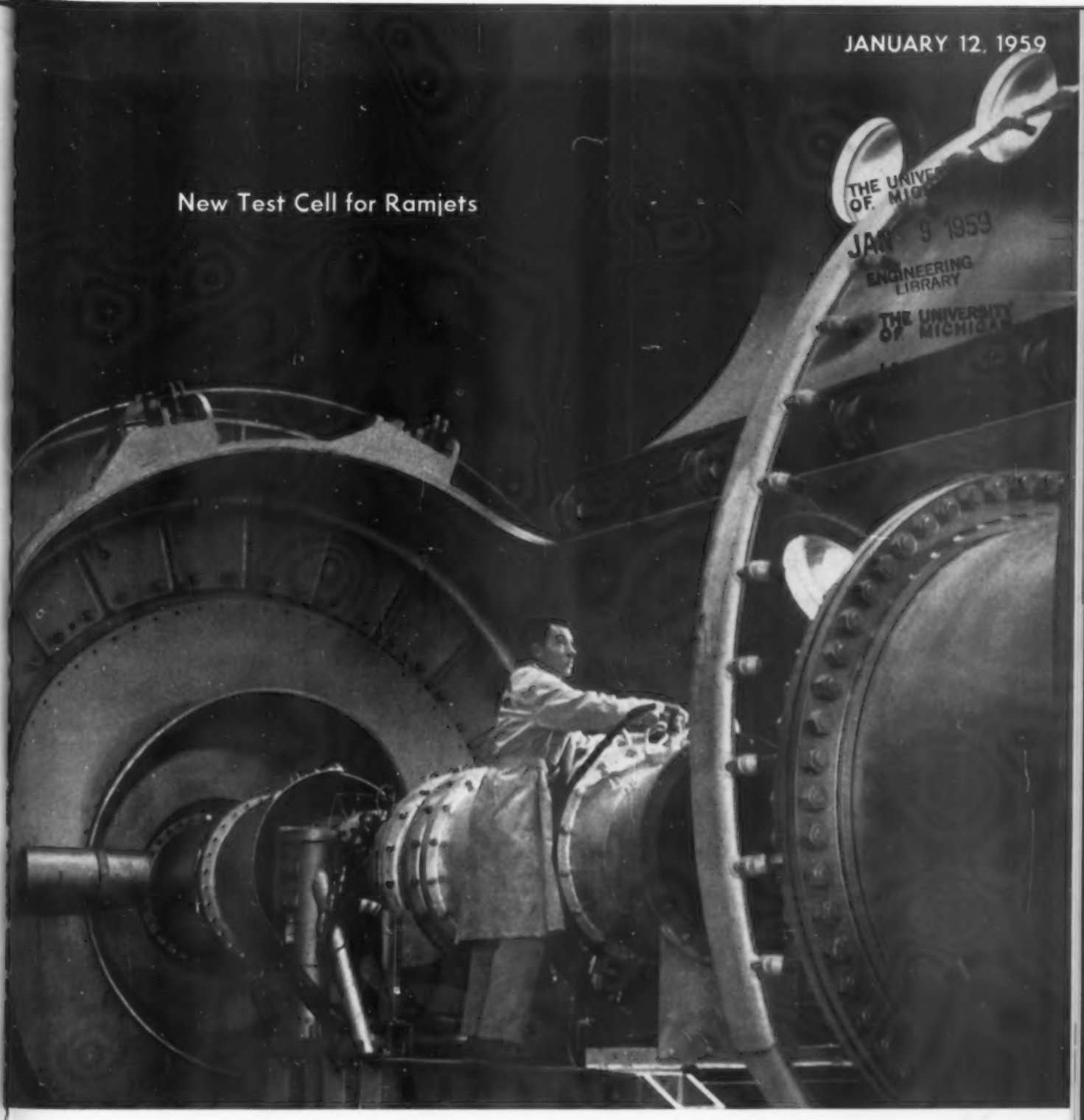
JANUARY 12, 1959

New Test Cell for Ramjets



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missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

Renegotiation Fight Looms . . . . p. 13
New Solids Battle . . . . . p. 16
USSR Plans Close Moon Orbits . p. 22

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Setting the pace in the field of evaporated film technology, Servomechanisms, Inc.'s Research Laboratory is developing a whole new concept of component and subsystem design under sponsorship by the U.S. Air Force, the Army Signal Corps and the Office of Naval Research.

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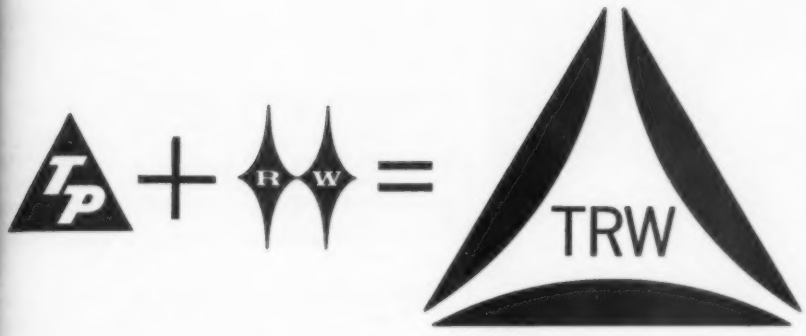

THE MERGER

The legal act of merging two companies into one does not of itself change the sum total of their capabilities. Thus, today the competence of the Ramo-Wooldridge Division for the development of electronic systems for military and commercial applications is indistinguishable from that of its predecessor organization, The Ramo-Wooldridge Corporation, while the skills of the Thompson Products group of divisions in the design and large-scale production of precision devices also remain unchanged. Soon, however, effects of the merger will begin to appear. One early effect will be an important addition of manufacturing strength to Ramo-Wooldridge programs, several of which have passed out of development and are in the prototype or manufacturing phases. Conversely, the special skills of Ramo-Wooldridge scientists and engineers in certain fields can usefully supplement the services that the Thompson Products divisions offer to their customers.

The formation of Thompson Ramo Wooldridge Inc. is intended to provide an unusual capability for the development and production of the complex electronic and mechanical devices and systems required by today's expanding technology.

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missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

JANUARY 12 HEADLINES

Congress Set for Renegotiation Fight

Industry pressing for elimination of Act, but it will settle for relaxation of objectional parts 13

***Bomarc* Engines Are Tested at Marquardt Lab**

Hugh facility stores 50 tons of air for supersonic testing at altitudes near 200,000 feet 15

Missiles in the News 18

***Lunik* Becomes Sun's Tenth Planet**

Indications are Russians may have hoped to hit moon; Exploit demonstrates know-how in velocity, guidance 21

ASTRONAUTICS ENGINEERING

Polyurethane-Polysulfide Battle Raging

Urethanes looking up in solid fuel-binder, with industry expecting I_{sp} of 275-300 seconds 16

USSR Lunar Probes Will Orbit Close to Surface

Technical data known on Soviet plans 22

MISSILE ELECTRONICS

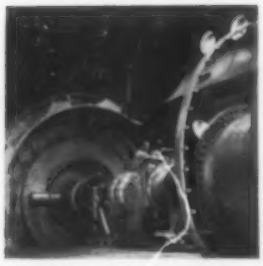
Detection Seen Possible by Star Occlusion

ACF technician proposes that telescope be mounted to space platform to do the work 23

Two-Dimensional Guidance Proposed 27

DEPARTMENTS

Washington Countdown ... 7
Industry Countdown 9
Moscow Briefs 34
Soviet Affairs 38
West Coast Industry 41
Book Reviews 43
Letters 45
Keeping Track 48
Contract Awards 51
When and Where 52
Editorial 54



COVER: Marquardt technician adjusts ramjet prior to cell testing. Story on p. 15

NEW FLOTATION gyro liquid undergoes environmental test at Sperry. Story on p. 27

MISSILE in the news is the IRBM *Thor,* which was scheduled last week to have made first *Discoverer* shot.

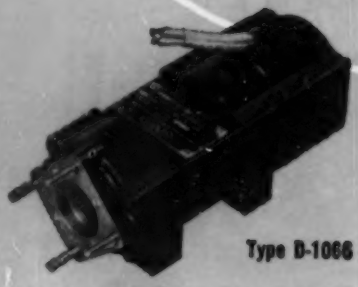
INSTRUMENTS that measured radiation belts in *Pioneer* space probe. See p. 18

FIBERGLASS astrodomes to protect instrumentation are now on the market. See p. 33

There is no substitute for

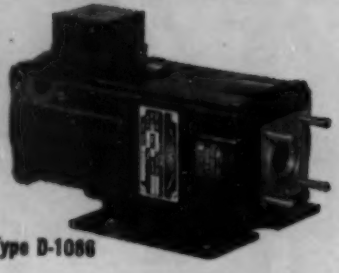
EXPERIENCE

when it comes to producing motors for the aircraft and missile field



Type D-1066

For supersonic aircraft applications. .71 HP DC motor, 7600 rpm continuous duty, 24 volt. For pump drive. Weight: 6.5 lbs. Meets MIL-SPEC M-8609.



Type D-1086

For missile applications. 9 HP DC motor, 12,000 rpm intermittent duty, 56 volt, explosion proof. Weight: 14.75 lbs. Meets MIL-SPEC M-8609.

Type D-878

For missile applications. Tested successfully at over 200,000 ft. altitude, this ⅓ HP, 27 volt DC motor (ranges 24 to 32 volts) delivers 12,000 rpm, weighs 2.75 lbs, has radio noise filter, is explosion proof. Built for high shock and vibration loading. Meets MIL-SPEC M-8609.

Type D-632

For fan, blower, pump applications. Only 6½" x 2¼", weight 23½ ounces, delivers 50 watts continuous duty at 7500 rpm. Long life. Small motor wound for 28 volt DC, or 110 volt AC or DC. Meets MIL-SPEC M-8609.

Here are eight special motors for eight different applications designed and produced by EEMCO for eight manufacturers of aircraft and missiles, and for related applications. Note the performance details for each: ratio of high output to size and weight.

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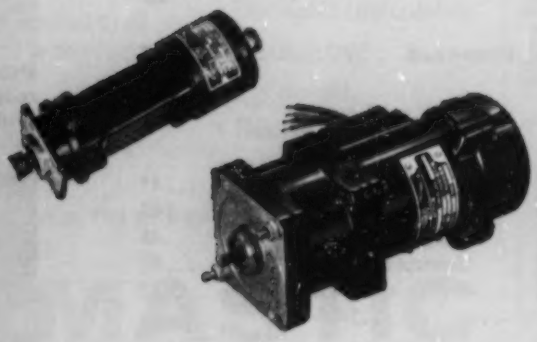
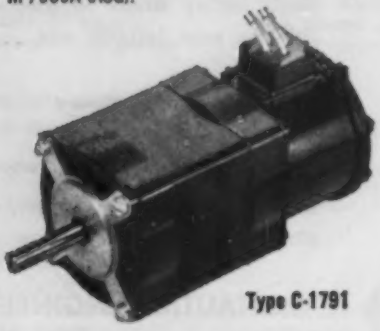
No matter what your problem may be in powering components for aircraft and missiles EEMCO has had experience that can help you. Your inquiry is invited.



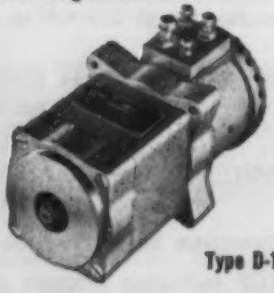
Type D-1068

For missile applications. 2.75 HP AC motor, 3140 rpm at gear box, continuous duty, 200 volt, 400 cycle, 3 phase. Power factor: 83%. Overall efficiency: 76%. Weight: 11.25 lbs. Meets MIL-SPEC M-7969A (ASG).



Type C-1791

For ultracentrifuge application. 1½ HP AC motor, 12,000 rpm continuous duty, 115 volt, 60 cycle, single phase, fan cooled. Weight: 12 lbs.



Type D-1025

For motor truck turbine engine applications. Starter-generator, weight 14.5 lbs. As starter: breakaway torque 220 in-lbs, terminal voltage of 20 volts. As generator: 40 amps continuously with intermittent peaks up to 80 amps at 28 volts.

Type C-1874

For actuator applications. 400 cycle, 3 phase AC motor and clutch. Intermittent duty, 12,000 rpm on 200 volts, 650 watts output. Weight: 4.5 lbs. Meets MIL-SPEC M-7969A (ASG).

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washington countdown

New House Space Chairman . . .

will be Rep. Overton Brooks (D-La.) presently second-ranking member of the House Armed Services Committee. Brooks will replace Rep. John McCormack (D-Mass.) the House Democratic Majority Leader, who has decided to step down.

Three months after . . .

organization of NASA, the nation still has no long-range space program, Dr. T. Keith Glennan, head of the civilian space agency, has announced publicly.

Navy and Army are up, AF down . . .

according to best estimates as to how FY 1960 defense budget will be divided among the three services. Compared with current budget, Navy will get an increase of about $300 million, Army will get about $300 million less. The $40.9 billion budget will be divided approximately as follows: Air Force, $18.6 billion; Navy, $11.8 billion; and Army, $9.3 billion; with an additional $1.2 billion for the Office of the Secretary of Defense. Congress added $1 billion to FY 1959, but the Administration has decided to hold nearly all of it until July 1, thus holding down current expenditures and the 1960 budget.

Congressional opposition . . .

already is shaping up against the Administration's proposed budget. Senate Leader Lyndon Johnson of Texas, has criticized it and the nation's space programs. He said there is no "substantial increase" in defense funds, and "we're not going farther, faster" in military and space programs.

Four more *Polaris* subs ordered . . .

just before New Year's (bringing the total to nine) will use up some of this additional money provided by Congress, but very little of the $600 million unfrozen will be spent before July 1. First warheads are expected to have a nuclear warhead equal to about 300,000 tons of TNT, and later models to equal a million tons of TNT.

Does Macy tell Gimbel's? . . .

contractors working on the WS-199 recently prepared press releases on the project. AF approved, but they were stopped cold when they hit Missile Boss Holaday's office. Reason: he reportedly didn't know an air-launched IRBM project was in the works by Air Force.

RAND is denying . . .

a statement semi-officially attributed to it that Russia will have 300 ICBMs within 18 months. Not its statement, belief or position, RAND says.

Ubiquitous Murray Snyder . . .

DOD's assistant secretary for public affairs, was first to move under reorganization directive. He informed services he was taking over direction and guidance of public affairs for the unified and specified commands, with direct communications thereto, and immediately called "the first world-wide unified and specified command information conference for Jan. 12-13." Snyder has not yet replied to service queries if he intended controlling release of all command information down to such things as military police incidents, aircraft accidents and supervising base histories.

First *Thor* squadron . . .

in England will be operationally ready in February, according to Maj. Gen. Bernard Schriever. *Thor* is 50% reliable now, he added, will soon be 80-90% reliable. *Atlas* will be operational by mid-1959, he said.

Navy is still boiling . . .

mad about cancellation of the *Regulus II* program. At a budget meeting of all service chiefs, Navy was told it had to cut, and cut in big chunks. All longer range air-breathing missiles, it was jointly agreed, would go. Navy reluctantly put the axe to *Regulus* assuming the across-the-board understanding would prevail. Realizing an interim weapon is needed until *Polaris, WS-199* or some comparable system is ready, DOD reportedly then threw additional money to continue the *Mace*. The decision in favor of *Mace*, according to one source, was made solely because *Mace* operates at a higher altitude. The Navy's $200 million cut was split down the middle in killing the Seamaster program and the *Regulus II* systems.

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8061-AC

industry countdown

New *Polaris* submarine . . .

to be built by General Dynamics, will be 5600 tons heavier than earlier models of the nuclear-powered submarine. Sub, with a price tag of $105 million, has been designed from the hull up to carry missiles. Advanced design work and parts procurement has been in progress for some time.

Army awarded Martin . . .

a $54 million contract to continue R&D of the *Pershing*. Martin will provide engineering, research, laboratory and testing facilities and a support system for development of the second-generation weapon at its Orlando facility. *Pershing* is a combined industry-military development concept. Engine tests have been made.

Lunar probe instrumentation . . .

developer, NOTS China Lake, has achieved remarkable successes in the space work assigned to it. The group is also part of the development team for the ARPA navigational satellite.

Army awarded Sperry . . .

an additional $22-million contract for continued development of the *Sergeant*. Work on the 30-inch diameter solid propellant missile will be done at the Utah plant. $13-million is for production of missiles for testing purposes, and $9-million for R&D.

***Hawk* production in Germany . . .**

will probably involve the electronic equipment for the missile while other hardware production will be the responsibility of France and Italy, if the planned NATO program is realized. Germans are highly interested in the British Bristol *Bloodhound* SAM for part of their air defense system.

Satellite mail delivery . . .

anywhere on the globe is under study by RCA. Brig. Gen. David Sarnoff, chairman of the board, reported that detailed studies have been made of possible uses of a satellite as an orbital post office for space mail delivery between the U.S. and Europe.

Grumman, Republic and Fairchild . . .

will work together whenever advisable on new astronautics projects to provide inter-exchange of compatible resources. The companies will collaborate on proposals for missile and space projects with ARPA and NASA.

Fairchild is slashed again . . .

with cancellation of the development of the J83 high thrust-to-weight ratio turbo-jet engine. It was originally slated for the *Goose* surface-to-surface long-range decoy missile that was cancelled last month. Fairchild plans to lay off more than 2000 employees.

Battery of *Lacrosse* missiles . . .

has been selected by the Canadian Army as a part of a new modernization program. The battery, including four launchers, associated fire-control equipment, and 12 missiles, initially will cost an estimated $1,198,000. Recurring annual cost; to replace missiles used in training will be $360,000.

Hercules Powder Co. . . .

has completed negotiations for purchase of the Young Development Labs of Rocky Hill, N.J., a manufacturer of filament-wound, glass-fiber-reinforced plastic materials. Young Development has worked with Hercules for many years supplying motor hardware for solid propellant rockets.

Martin has set up a new corporate office . . .

Manager of Electronics Requirements, for coordinating future missile business.

$10.5 million expansion . . .

program of Ramo-Wooldridge, a division of Thompson-Ramo-Wooldridge inc. will be on a 90-acre site in Canoga Park, Calif. First six units are to be completed late this year.

Merger is planned . . .

between Texas Instruments Inc. and Metals and Controls Corp. of Attleboro, Mass., on an exchange-of-stock basis.

(right) Part of giant capacitor bank used to fire "hotshot" tunnel. Bank is capable of 5 million kilowatt jolt.

(above) Lockheed's "hotshot" tunnel – only one in private industry.

(right) Research and Development facilities in the Stanford Industrial Park at Palo Alto, California, provide the latest in technical equipment.

EXPANDING THE FRONTIERS OF SPACE TECHNOLOGY

Lockheed capabilities in thermodynamics and gas dynamics are unsurpassed in private industry. Basic work is being performed on problems relating to missiles and spacecraft under simulated conditions of upper atmosphere and outer space. Studies include: boundary layer flow and heat transfer; cooling and insulation; thermodynamic instrumentation for flight test; design of rocket motor controls and nozzle structures; re-entry thermal protection; materials specification; and thermal environments of electronic, mechanical and hydraulic equipment. Also under study are new methods and improved techniques of thin film thermometry, measurements of dissociation and combination of nitric oxide and high-speed shock wave flows.

Equipment includes the fastest wind tunnel in industry, fired by 20 million kilowatts; a hydromagnetic tube which produces velocities of over Mach 250 and temperatures approaching 500,000°K; a "hotshot" tunnel for shock wave, gas and heat studies, capable of velocities of 16,500 mph and temperatures above 12,000°F; and a ballistic range on which projectiles are fired at speeds up to 20,000 ft/sec.

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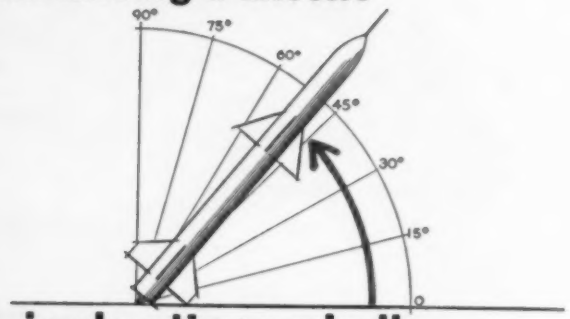
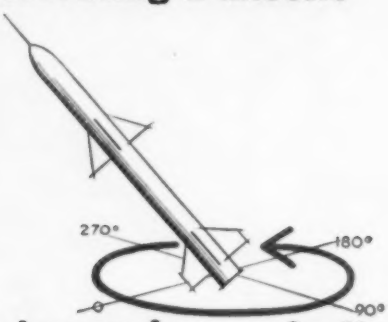


...in elevating a missile



...in traversing a missile

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missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

Congress Set for Renegotiation Fight

Industry groups press for elimination of 17-year-old Act labeled costly and discriminatory. But they will settle for relaxation of objectionable features.

Pentagon dislikes system but can't say so publicly. Saltonstall bill would exempt many contracts and boost incentive for manufacturers.

by E. E. Halmos

WASHINGTON—Sen. Leverett Saltonstall (R. Mass.) is expected soon to introduce a bill aimed at loosening some of the most unpopular controls of the World War II-born Renegotiation Act.

A stiff battle is already shaping up, even though Congress has only recently opened its doors for new business. Already U.S. industry forces have been meeting together and with their allies on Capitol Hill to map strategy.

Saltonstall, a member of the Senate Armed Services Committee, is readying legislation which would exempt from renegotiation:

1. Any contracts (or procurement) entered into after formal advertisement for bids;
2. Contracts entered into after competitive negotiations;
3. Contracts which include incentive clauses.

Near the end of the 85th Congress, last summer, industry—with missile manufacturers playing an important part—won a minor victory by getting Congress to extend the Renegotiation Act by only six months, instead of the two years originally proposed.

Congress promised to make an exhaustive study of the 18-year-old law, before considering new legislation this year. Hearings may get underway by the end of this month.

The issue:

Industry concerned with defense—and that cuts a broad swath through the entire U.S. industrial community—feels that renegotiation is a wartime measure that has become, in peacetime, nothing more than a retroactive tax. Worse, it feels that renegotiation now actually deters efficient production, reduces incentive, and in fact makes defense more and more costly to the American taxpayer. Worse still, it sees the law being used as a broadsword to enforce the power of government agencies over the U.S. economy.

Spearheading the proponents of the law is the Renegotiation Board itself, headed by Thomas Coggeshall, which feels that the law is a guarantee against excessive profits by industry at the taxpayers' expense.

The armed forces themselves—beneficiaries or victims of the system—are in the middle, and trying carefully to steer a course that will antagonize no one. Privately, government contracting officers feel that the law is now, in effect, a criticism of their own abilities. The need for renegotiation implies, they feel, that the men who made the original contracts weren't competent to obtain fair prices from the contractors.

The fact is that industry doesn't expect to achieve a complete knockout, although the expressed aim of its actions before Congress is the complete elimination of the Renegotiation Act. Actually, industry will be satisfied this year if it can succeed in easing the act's provisions to allow more freedom.

—The Controversy in Brief—

- **Renegotiation began . . .** in 1941 when the U.S. was in a hurry for war materials. Congress passed the act as a safeguard against exorbitant profits. It has been in effect since, except for 1946-47, but is slated to die this year. The Renegotiation Board may approve profits or require manufacturers to return part of them. There's no appeal except to Tax Court.
- **Proponents claim . . .** the law is needed to prevent excess profits at the taxpayer's expense.
- **Industry complains . . .** the present set-up ties up profits pending Board rulings, hits at incentive, hurts small business.
- **Unhappy Pentagon . . .** contract negotiators feel the system reflects on their competence.
- **Opponents contends . . .** industry and government now have the know-how to set fair and accurate prices; the government has other safeguards against excess profits anyway, and more incentive would benefit both industry and taxpayer.
- **Likely outcome . . .** is a compromise—not wiping out the law but creating exemptions.

• **What is it?**—The whole question of renegotiation is one that is only hazily understood by the general public, and it is even hazy to many industrial people who are affected by it.

Briefly, its history goes back to 1941, when—under the stress of wartime conditions—the U.S. government found it necessary to enter into thousands of contracts for war materials in great haste. There was no time for careful negotiation, estimating or studying of previous experience in producing these items. In fact, there was no experience at all in manufacturing some of the items. In other cases, the nature of the procurement was so secret—and the need for speed so great—that it would have been impossible to advertise for public bidding.

Congress, worried by the possibility of exorbitant profits under this stress, passed the Renegotiation Act. It was actually a provision for an open contract—for re-examination at a later date of the actual costs of producing the item in question, and readjusting the price paid by the Government for the item, if it was found that the original estimates were out of line.

What happens is this: At the end of his fiscal year, the defense contractor who has handled $1 million or more of defense business must submit to a district Renegotiation Board (now located in New York, Chicago

and Los Angeles) a complete and complex statement, reporting and justifying his earnings and the prices charged. The regional board reviews these figures, makes a ruling as to whether the profits shown are reasonable, or whether the manufacturer must return some of his profits to the government. Regional board actions are subject to review of a Statutory Board, headquartered in Washington, under Mr. Coggeshall's chairmanship.

The Statutory Board's actions can be appealed—but only to the Tax Court, whose decisions, in turn, cannot be appealed to regular civil courts.

The law was in effect continuously from 1941 through 1945, lapsed from 1946 to 1947, then was reinstated and has been in effect since 1948.

• **Long time no pay**—The whole process of submission of evidence, board review and decision and final determination has seldom taken less than two years, and more normally has taken up to four years.

Here is one of industry's major complaints. This long-drawn-out process has meant, in real terms, that profits earned in any one year must virtually be segregated for a period of two to four years ahead, because the workings of renegotiation may result in the manufacturer having to return all or part of the money.

As a result, money that would be plowed back into the business, to improve facilities or be devoted to research, or that might be returned to investors as dividends, is frozen until the slow grinding of government machinery frees it. Worse still, the profit may not even exist—the government may take it all back.

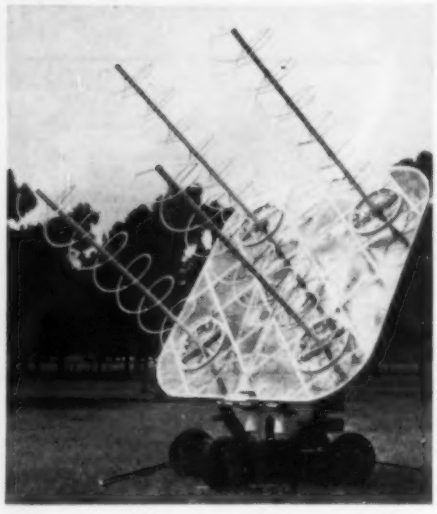
In the years 1952-1954, as one example, Boeing had to refund a total of $27.5 million of its total earnings as result of decisions of the renegotiation board.

• **No incentive?**—Probably most aggravating point to manufacturers—and to the armed services—is the fact that incentives for efficient work are apparently meaningless in the light of renegotiation provisions.

For example, many of the contracts entered into by the government agencies provide an incentive for manufacturers, if they can produce the item at better than the agreed-upon costs. For example, a manufacturer, after negotiation and careful consideration of his costs, may agree to produce an electronics item for, say $120 each.

If he is very efficient, watches his operations and his costs, he may be able to produce the item for, say $100. His contract with the government encourages him to do this—it offers him 20% of the savings he effects as his reward for efficiency. The government, in turn, benefits to the tune of 80% of the savings.

Atlas Antenna



RADIQUAD ANTENNAS are being used to send and receive messages from the *Atlas* satellite at strategic spots around the U.S. Built for the Army Signal Corps by Radiation, Inc., of Melbourne, Fla., this antenna will transmit and receive to separate telemetry and message channels simultaneously.

However, provisions of these incentive-type contracts limit his actual total profit on the item to 12%. And then, renegotiation some years later may force him to give up the incentive earnings—as has happened on several occasions.

The result, say industry proponents, is that there is no incentive to produce more efficiently. If you agree to produce an item for $120, see to it that it does in fact cost that much. Then you can collect—with some certainty—the profit you've figured, without so much chance of losing it all.

• **Small business hurt?**—Another result, say industry people, is damage to small operators. And the missile field, in particular, is largely made up of small operators.

Reason: One of the criteria for determining whether a profit has been excessive is the net worth of the prime contractor—how much he has invested in physical plant and equipment.

Thus it might pay a prime contractor to acquire plant and equipment to do work that he might otherwise let out of his shop on subcontract. Every bit of equipment he himself owns is countable as part of his net worth. So he may save on the renegotiation consequences if he does more work himself, even if it is uneconomic from any other viewpoint for him to do such work.

A second reason is of course obvious: If the prime has trouble collecting his money, the subcontractor must wait that much longer for his share—or at least his payments are uncertain.

From the viewpoint of the armed services, there is another serious point: If renegotiation is necessary now, it means in effect that the contracting officers are considered to be incompetent. If they can't be trusted to sign contracts and negotiate contracts that will produce the best possible results, at lowest cost for the government, then renegotiation is necessary.

• **Answers**—Industry in general—and the Aircraft Industries Association, the Electronics Industries Association and the U.S. Chamber of Commerce have spearheaded the attack—makes these points in its arguments against renegotiation:

1. During and since World War II government agencies and industry both have developed sufficient know-how to arrive, in most cases, at fair profit figures for production of defense materiel.

2. Among the devices available to the government, as a guard against excessive profits, is the cost-plus-fixed-fee contract, worked out successfully during the war.

3. Industry should be allowed the incentive of more profit for efficient operation.

4. The defense industries—particularly those concerned with aircraft and missile production—have been unfairly penalized in relation to other industries, by arbitrary actions of the Renegotiation Board, which has cut profits down below that of general industry, in relation to net worth.

5. Existing laws such as the Vinson-Trammel Act put a ceiling on defense profits, anyway.

• **Realities**—No one believes that the result of this year's fight in Congress will be complete elimination of renegotiation. The subject is too popular politically, for one thing. And no one denies that there have been flagrant examples in some industries of excessive profits at government expense—although those examples are far from the majority.

What seems reasonable to expect is a compromise, such as that embodied in the bill being readied for introduction by Senator Saltonstall.

The result has to be a better climate for business, better value for the dollar, say proponents.

They have a long, tough fight ahead against opponents who claim, in effect, that industry is not to be trusted.

Bomarc Engines Are Tested at Marquardt Lab

Huge facility stores fifty tons of air for supersonic testing at altitudes near 200,000 feet

by Raymond M. Nolan

VAN NUYS, CALIF.—In all *Bomarc* firings from Cape Canaveral in 1958, there was not one abort due to ramjet failure. One basic reason for this success is the Jet Laboratory operated by Marquardt Aircraft Co. for the *Bomarc* engine development program.

The laboratory, modernized and dedicated last fall, is one of the world's largest and most powerful facilities for testing supersonic air-breathing engines and components for missiles.

The facility, jointly financed by the USAF, the Navy and Marquardt, has been operated since 1949 by the company. Prior to its modernization it was a major element in the development of the propulsion system for the *Bomarc*, powered by two ramjets. More than 100 flights have proved that the *Bomarc* propulsion has reliability of greater than 98% with 95% confidence.

The modernized laboratory permits testing of engines 5 to 6 feet in diameter at altitudes approaching 200,000 feet and Mach numbers of 4½ capable of being extended to Mach 7. The laboratory now includes eight specialized engine test cells, complete fuel controls and systems testing facilities for both ambient and environmental conditions, as well as accessory testing capabilities and smaller-sized research-type test installations. This week's m/r cover picture and photographs on this page were taken in Cell No. 8 in the laboratory.

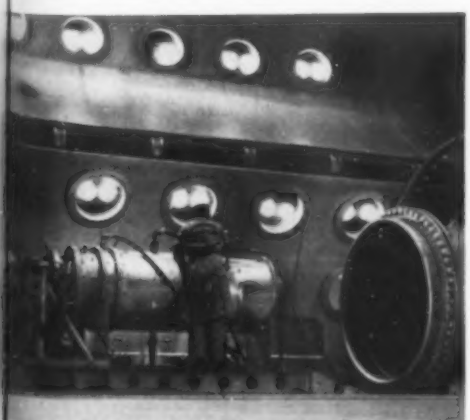
The facility has several unusual features. One of these is an air storage system for the large quantities of air needed for supersonic ramjet testing. A total of 100,000 pounds of air is stored in 10 vessels that range in weight from 55 to 110 tons each.

As this air can be blown down in less than a minute—a satisfactory figure for ramjet testing—it would require a compressor installation well in excess of 200,000 hp to provide a similar continuous capacity. The actual compressors installed total 4250 hp, making an overall delivery system of approximately 10 per cent of the ordinary cost.

• **Heaters used**—Two large heaters are used to simulate the stagnation temperatures at very high speeds. The first heater, a part of the original laboratory, provides temperatures up to 700°F and has been in constant use during the development of the *Bomarc* engine. The other heater, installed as part of the modernization program, provides air up to 1200°F. The major exchange surfaces on the newer heater are made from chromized steel, reportedly the first time this material has been used in a large heat exchanger. This process changes the outer surface of the material to nearly pure chromium, giving good corrosion properties.

In the exhauster system, five J-47 turbojet engines are used to drive the turbines of 10 J-33 turbojet engines. The turbines supply more than 30,000 shaft hp to their compressor sections, which in turn exhaust the air from the test cells. For large mass flows at medium altitude, the system operates as a single stage. However, for extreme altitudes it is operated in a multistage configuration.

TECHNICIAN READIES ramjet for testing. Facility can change engine angle-of-attack during testing.



OBSERVATION PORTS are visible in test cell.

RAMJET ON stand as seen through exhauster.

Polyurethane-Polysulfide Battle Is Raging

Urethanes looking up in fuel-binder struggle. Industry expecting to get I_{sp} of 275-300 seconds in near future

by Alfred J. Zaehringer

DETROIT—What's new in the fuel-binder battle of solid propellants? The large grain struggle—particularly for ballistic missiles—hinges on polyurethane versus polysulfide. And industry advances are remarkable to say the least.

Let's talk a little history:

Possibly the biggest single advance in solid propellants was made during World War II at CalTech's Jet Propulsion Laboratory. The fuel-binder of the old asphalt-perchlorate thermoplastic combination was replaced with a polysulfide polymer.

This move permitted internal burning grains and allowed the use of thin-wall combustion chambers. The solid propellant people were then given a large increase in mass ratio.

Solids could finally compete with liquids. Then, the potassium perchlorate oxidizer was replaced by the higher energy ammonium perchlorate. By and large, the ammonium perchlorate (AP) oxidant-polysulfide fuel binder has eliminated the composite solid propellant picture. The liquid polysulfide polymers (LP) ushered in the era of castable propellants that could take severe temperature cyclings.

On this wave of increasing AP-LP applications, Thiokol Chemical Corp. was able to ride up—possibly to the top of the solid propellant heap.

But despite the good features of AP-LP propellants, there were several disadvantages:

1. High polymer cost and relatively low volume.
2. Polymer production tied to one manufacturer.
3. Polymer production critically related to sulphur availability.
4. Long cure times.
5. High molecular weight exhaust products.
6. Objectionable sulphur compounds in exhaust for some applications.

It is known that Aerojet-General Corp. has done extensive work with the low cost polyesters. It is further suspected that Aerojet's Aeroplex propellants of today are based on polyesters. One source states that Aerojet is using the Rohm & Haas Paraplex polyesters.

Paraplex consists of the reaction product of a dihydric alcohol with a dibasic acid dissolved in monomeric styrene. Atlantic Research Corp. has done work on vinyls, Shell Oil Co. may be working on epoxies, and American Rocket Co. on the poly nitrogens. Goodrich, Phillips, and Standard Oil are all working with various synthetic rubbers or elastomers as solid propellant fuel-binders.

An elastomer can repeatedly be stretched to 150% or more of its original length and snap back to its original state. However, despite "hot" claims and "no comments" most, if not all, solid people are taking a serious look at the polyurethanes.

• **What are polyurethanes?**—The polyurethanes were born in Germany in the 1930's. After the war, the German Farbinfabriken Bayer AG was particularly active in developing new urethane foams, coatings, adhesives, and elastomers. The urethanes finally came to the U.S. in the 1950's.

Chemically, a polyester couples with urethane links (a diisocyanate) to form a polymer. The cross-linking is accomplished by means of heat or catalysts. However, if excessive diisocyanate is present, the addition of water will give off carbon dioxide gas. This CO_2 is desired to produce foams but is undesirable for solid propellants. One of the requirements of an ideal solid fuel-binder is that no reaction products be given off in the formation of the solid polymer. Here is one area where the application of urethanes to solid propellants could be troublesome.

In general, the urethane elastomers are solvent-resistant, have good oxygen content (important for fuels), and display excellent physical properties at low temperatures (–70°F) and at temperatures up to 300°F. The high temperature properties (Figure 2) are especially important.

Solid rockets are being used for vernier control of ballistic missile warheads. Here the solid propellant will also act as a heat sink where high temperature resistance is desirable. Present high end temperature specifications call for about 170°F but the handwriting on the wall indicates that solids will have to be able to take at least 212°F within the next two years. By 1962, solids must be able to withstand 250-300°F for certain applications.

• **Two types available**—The elastomeric urethanes are rubber-like gums when cured. They are available as liquid polymers or solids. The liquid polymers can be catalyzed and mixed with oxidizer to give composites of a castable or extrudable nature.

The solid urethanes are much like natural or synthetic rubber which can be compounded with oxidizer on a two roll mill or in a Banbury mixer. Various fillers (the oxidant is the filler) can also act to reinforce the elastomers.

Plasticizers (such as TCP) could also be added to ease processing or to impart special properties to the finished propellant (such as high-temperature anti-oxidation or low-temperature flexibility).

Another advantage of the urethanes is high adhesion. Being very good adhesives, such propellants can give case-bonded grains. Also the fact that the polymers are thermosetting (viz., do not melt when heat is applied) makes them suitable for internal-burning grains.

For safety and ease in processing, ammonium perchlorate urethanes would probably have to be handled as liquid castables. It is conceivable that ammonium nitrate urethanes could be milled for propellant production. Phillips, for example, has successfully hot, dry milled ammonium nitrate and synthetic rubber. Ammonium perchlorate, on the other hand, is quite friction-sensitive when mixed with fuels.

• **Ballistic advantages**—There are two big thermochemical advantages in the use of the urethanes:

1. Possibility of incorporating oxygen into the polymer molecule.
2. Nitrogen which can go to the free state.

The first, oxygen incorporation, is especially important. For most organics, some 85-90% of the propellant, by weight, must be oxidant for stoichiometric conditions. Any non-oxidized oxygen which can be built into the fuel molecule will help.

Then, there is talk of adding metals (aluminum, magnesium, or boron) or even the boron hydrides to the fuel to increase heat content. With ordinary composites, the propellant formulator cannot stand too much additives addition without harming the already critical physical properties of today's oxidizer heavy solid propellants.

Simply stated, to take full advantage of higher heat content fuels without ruining propellant physicals, more oxidizer must be added. It would appear advantageous to get the fuel-binder to do some oxidizing also. Aerojet is now reported working on this very approach.

Next, the nitrogen in the molecule could go to free nitrogen N_2 with a molecular weight of 28. This compares with the 32 of free sulphur or 64 for SO_2 which are among the reaction products of today's polysulfide propellants.

Dropping molecular weight can be just as important as increasing heat content. Factually, to make significant performance advances, heat content should go up and molecular weight of exhaust should come down.

Then, the cross-linking nature of the polymer (which can take place at room temperature with the proper catalyst) could allow the incorporation of high energy components such as the nitro (NO_2) or nitrate (ONO_2) groups as oxidizers or the amine boranes (dimethlyamine-borane, trimethylamine-borane, or pyridine-borane) to increase the heat content of the fuels.

The latter is viewed as especially interesting since the active hydrogen amines are used to cure the polymers. Callery Chemical is promoting the amine boranes as polymerization catalysts. Thus, more stable boron propellants could result by utilizing the cross-link method rather than simple mechanical incorporation.

• **Who is working on urethanes?**—Right now the field is far from stabilized. Here are some of the activities that have been revealed or implied:

1. **Aerojet-General**—Reportedly working hard and furiously on polyurethanes—particularly with ammonium perchlorate and metal addition on the *Polaris* propellant program. Aerojet supposedly has hit the 270 I_{sp} mark with the urethanes. Significantly, General Tire & Rubber, Aerojet's parent firm, is pilot plant producing the "Genthane" polyurethane elastomers at its Akron Chemical Division but is also looking hard at the polyether-polyurethane field.

2. **Atlantic Research**—This solid propellant firm is believed to be working on polyurethane solids. It has openly advertised for urethane scientists. Whether it has given up its vinyl program is not known, however.

3. **American Rocket Co.**—Working with the polyether-polyurethanes to form castable solids.

4. **DuPont**—Has considerable patent holdings involving the use of isocyanates for polyurethanes—particularly for foams and other commercial applications. Apparently no propellant interest at the present time.

5. **Monsanto**—This is the firm to watch. Monsanto has a longstanding interest in solids (producer in World War II and R&D activities during the Korean war). It has joined with Bayer of Germany to form Mobay Chemical to exploit polyurethanes. Mobay's solid urethane elastomer Vulkollan has shown an alongation of 600-800% (natural rubber is about 550% tops). The polymer is a free flowing, thin liquid which might make an ideal fuel-binder.

6. **Reichold**—Producing polyesters for polyurethanes. Apparently no solid propellant interest.

7. **Rohm & Haas**—This polyester producer operates a solid propellant R&D laboratory at Redstone. May be on an urethane solid propellant evaluation program.

8. **Thiokol Chemical**—Producing the ZL polymers containing diisocyanates for foam applications. It has looked at polyurethane solids, and sees no overall advantages over polysulfides. However, probably Thiokol is quietly doing much R&D work in the back end.

9. **Wyandotte Chemical**—Use of its polyols (polyoxyalkylene glycols consisting of blocks prepared from propylene and ethylene oxides) would permit significant cost reduction in the polyurethanes for solids. At the present time this is an unknown factor in the solid picture other than a present supplier of polyols.

Polaris Is User

AEROJET IS WORKING hard on polyurethanes particularly for its *Polaris* program.

• **Ballistics good**—Reports have it that Aerojet has hit 270 with its polyurethane propellant—probably ammonium perchlorate. Whether this is theoretical tops, actual test stand (corrected for altitude), or is with additives is not known.

One report has it that an all ammonium nitrate polyurethane propellant has hit an I_{sp} of 210 sec without high energy fuel additives at sea level conditions in test stand runs.

This—if true—means some 10-20 seconds over the performance now realized with present fuel-binders. And, it means that ammonium nitrate solids with high energy additives could compete with the present ammonium perchlorate combinations which are giving about 225 seconds in actual test stand runs at sea level conditions.

It is felt that ammonium nitrate can give an I_{sp} of about 240-250 seconds with the envisioned high-energy additives. Probably an ammonium perchlorate-polyurethane combination (without additives) could give an actual I_{sp} of 240-250 seconds.

However, lithium perchlorate or nitrate might be able to go a little higher but not much more; and it might be possible to get a lithium propellant to 275 I_{sp} with high energy components.

Burning rates of the urethane propellants will probably tend to be higher than with the polysulfide polymers.

• **Conclusion**—Summarizing, the urethane solid propellant picture looks like this:

1. Ballistic properties. Good to excellent. Possibility of introducing more oxidizer and/or high energy fuel components.

2. Availability. Growing and much better than polysulfide. Independent of critical sulphur during war.

3. Cost. On a par with polysulfides but dropping radically. With polyethers. They are almost on a par with the vinyls or polyesters which are among the lowest cost, high volume polymers in production.

4. Heat stability. Good to excellent.

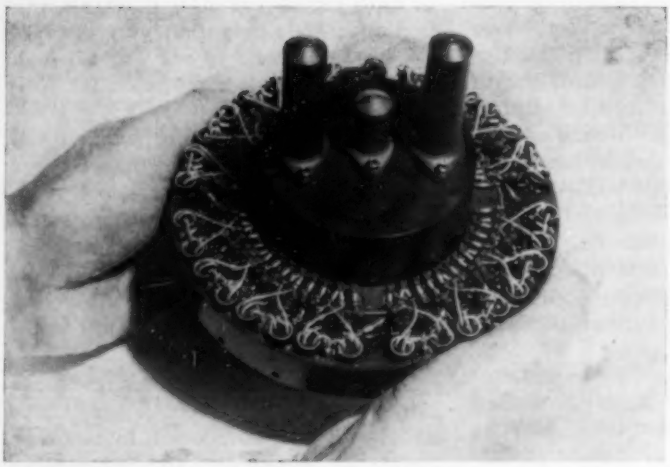
5. Physicals. Good to excellent.

6. Storage. Long term conditions unknown.

7. Processing. Fast. Involves use of toxic materials.

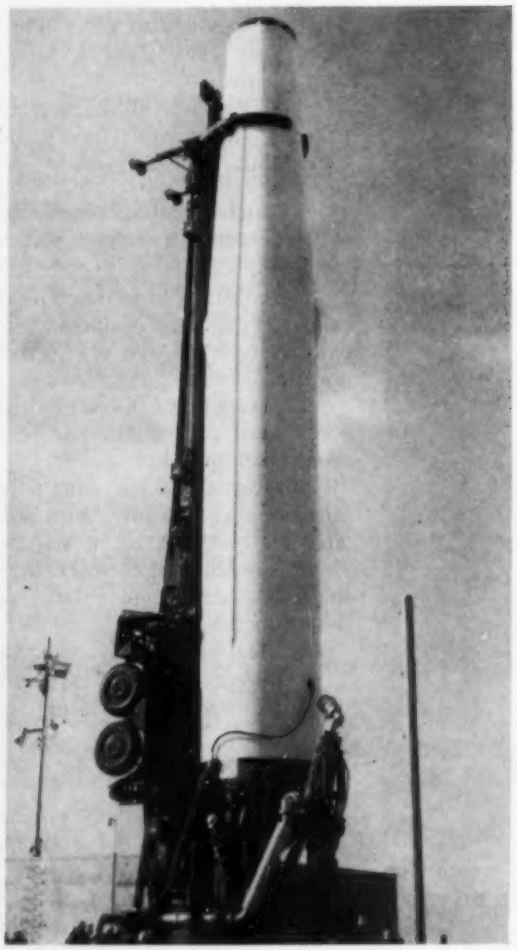
For these reasons, polyurethanes offer better than 250 I_{sp}. In fact, with molecular modification, it may not be too long before the U.S. has solids giving an I_{sp} of 275-300 seconds.

missiles in the news...

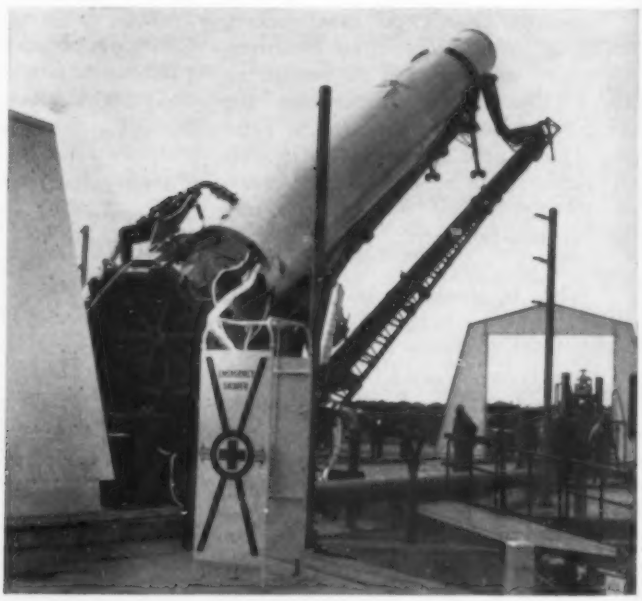


INSTRUMENTS THAT measured the two radiation belts during the flight of *Pioneer III* on Dec. 6-7. The two Geiger-Mueller tubes measured the intensity levels.

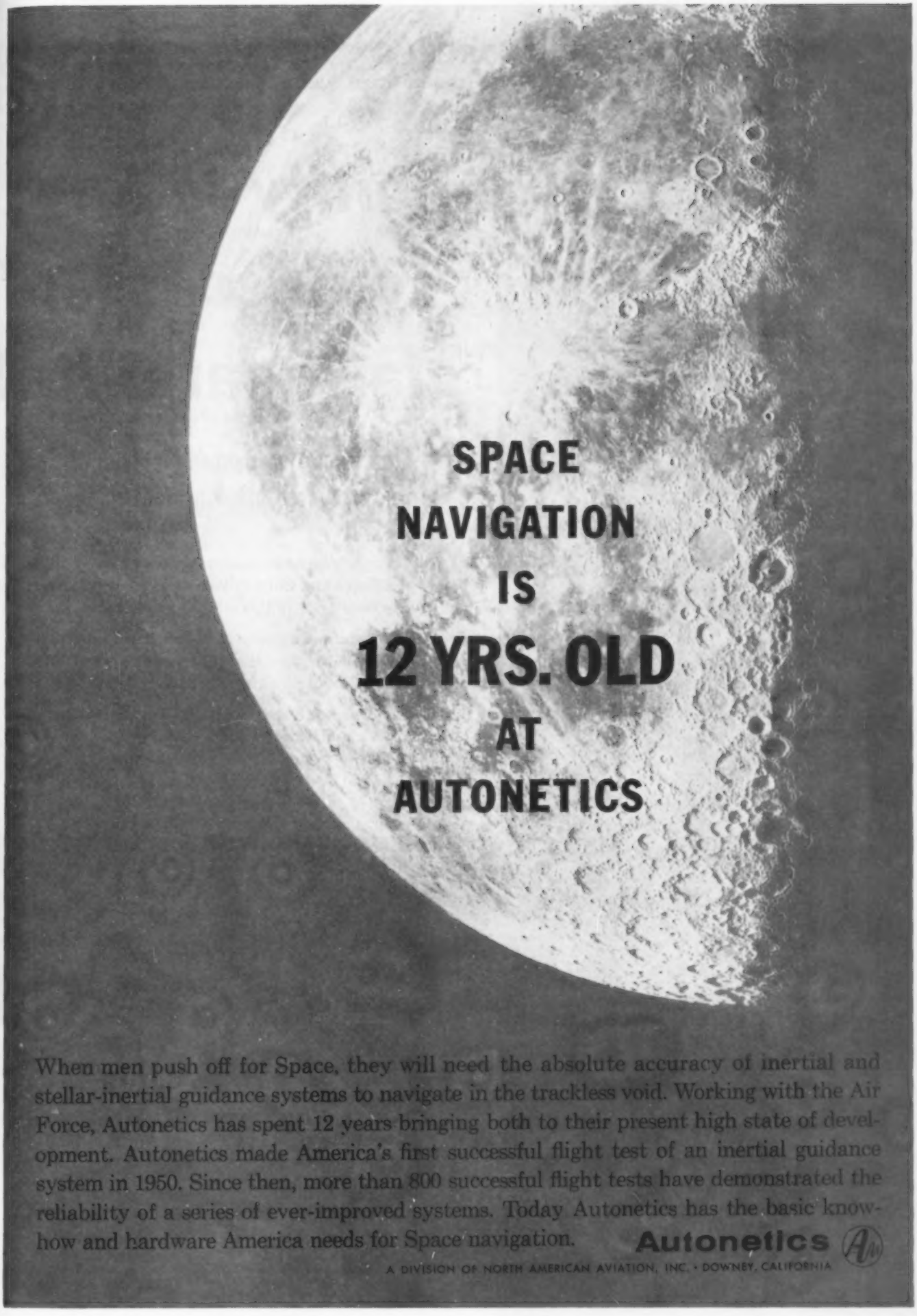
THE TENTH flight of the SAGE series recently was completed by *Bomarc*. The Air Force surface-to-air missile has racked up an impressive score.



THE FIRST operational *Thor* IRBM fired Dec. 16 from Vandenberg AFB was minus the fins used on earlier missiles.



***Thor* IS ERECTED to vertical launch position by its transport erector on Vandenberg pad 75-1 as the protective shelter moves away.**



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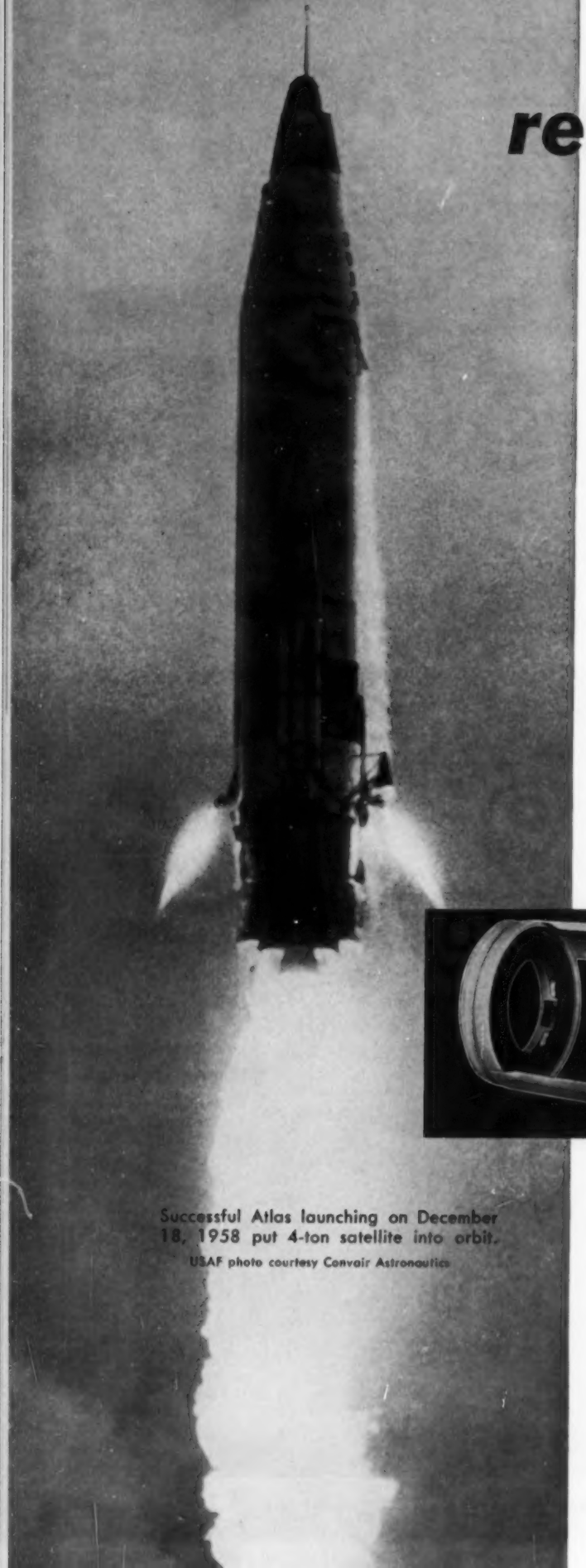
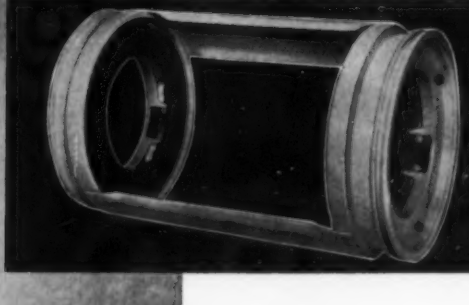


Successful Atlas launching on December 18, 1958 put 4-ton satellite into orbit.
USAF photo courtesy Convair Astronautics



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Lunik Becomes Solar System's Tenth 'Planet'

Indications are Russians may have hoped to hit moon; exploit demonstrates know-how in velocity, guidance

by Norman L. Baker

WASHINGTON—*Lunik*, the tenth "planet" of the solar system, is slowly pushing farther from the earth as it moves into its orbit as a captive asteroid of the sun.

Seven and one-half months from now, Russia's man-made contribution to the solar system will be somewhere between the orbits of Mars and Jupiter in the asteroid belt.

This week the Soviet "lunar probe" will be at its perihelion to the sun—approximately 91.5 million miles distant. At the apogee of its 15-month (447 days) orbit it will be 214.75 million miles out from the sun and about 120 million miles from the earth.

If and when, its perigee coincides with the position of the earth (some scientists say hundreds, others millions of years), *Lunik* would be pulled back into the gravitational field of the earth. It could, conceivably, be pulled into the gravitational field of Mars or one of the many high-mass asteroids.

According to preliminary calculations by the Russians, the eccentricity of the probe's orbit is 0.1418. The major axis of the orbit is at an angle of 15 degrees and 11 minutes to the major axis of the earth. The plane of *Lunik's* orbit almost coincides with the plane of the earth's orbit.

• **Commemorates Seven-Year Plan**—The probe was launched Jan. 2, undoubtedly to commemorate the start of another Soviet seven-year plan, and possibly as a bargaining tactic for Anastas I. Mikoyan, Soviet deputy premier who is visiting the U.S.

Russia was still receiving data from the payload early last week when it was almost 400,000 miles from the earth. With its radios now dead the chances of locating and tracking the "planet" in the years to come will be very slim.

Lunik's maximum velocity (at perigee) will be about 75,000 mph. This will be the accumulative velocities of the earth (66,700 mph) and the vehicle (velocity of the vehicle plus the "pulling" induced-velocity of the sun). Its maximum velocity (at the time of burnout) was about 90,000 mph with respect to the sun.

Conflicting reports make it impossible to sift out the Russians' original intentions in launching their probe. According to the Russian founder of the International Astronautical Federation, Alexandre Ananov, excessive velocity prevented them from hitting the moon, the intended target.

The marking of the payload with the Soviet symbol, inclusion of a pennant and the inscription "USSR, January 1959"—for possible later verification—and the tagged title of the payload, *Lunik*, seem to verify Ananov's claim. Instruments aboard also substantiate this premise.

Yet the Russians announced within hours of the launching that *Lunik* would pass within 3726-4968 miles of the moon. At 9:59 P.M. (EST) Jan. 3 it passed the moon 4660 miles from the lunar surface (within one hour of the calculated time of 11:00 P.M.). Of course, the fact that it was going to miss the moon would have been known within minutes after learning the burnout velocity and attitude of the final stage. It appears the Russian scientists were prepared for any eventuality.

It is indeed probable that guidance error killed original Soviet intentions of a lunar orbit. In this issue of m/r, (p. 22) LCDR John A. Fahey, Head of the Foreign Language Division of U.S. Naval Intelligence School, points out that Soviet data indicates an intent to orbit at heights of 10 kilometers (6.2 miles), and 50 kilometers (31 miles). He said he expects another attempt in the "very near future" to achieve these goals.

Close orbits of the lunar body, according to m/r Contributing Editor Dr. Albert Parry of the Department of Russian Studies, Colgate University, have been publicly proposed. He quoted an article by Academician N. Barabashev, director of the Kharkov Observatory in the Ukraine.

Barabashov wrote in Izvestia that it was "imperative at this time to compile an exact atlas of the moon's surface."

Two outstanding disclosures of Soviet missile and space know-how resulted from *Lunik's* flight. First, the Soviets undoubtedly once again utilized the *Sputnik* launcher, the T-3 two-stage ICBM, with its tremendous thrust power of about 500,000 pounds.

Also, the accuracy with which they made the calculated close approach to the moon (or missed it by less than 5000 miles) indicates that Soviet guidance problems are not the bottleneck our military experts had thought.

Apparently the Soviet scientists made maximum utilization of *Lunik's* payload of 796.5 pounds. Final stage of the carrier rocket attached to the payload weighed about 3240 pounds. Measurements of the moon reportedly included magnetic field strength, gravitational forces, cosmic ray intensity, sediment evaluation of the lunar craters, properties of the moon's inner strata and optical teletransmission of the moon's surface.

• **No photos**—Although there has been no indication that instruments were aboard enabling the Russian scientists to receive pictures, one report stated *Lunik* was equipped with telescopes for observing the surface at close range. If so, instruments included in the payload were possibly more advanced than the scanner instruments in our *Pioneer* probes.

It was reported shortly after the *Lunik* launching that some Pentagon officials had known of the Soviet probe beforehand, but the report has not been officially verified. Tracking stations at Cape Canaveral were idle as the space probe began its journey toward the moon.

Orders from the Pentagon put the Cape trackers into action the next day. JPL and the Goldstone Tracking Station announced they had received no advance knowledge but made hurried modifications to tracking equipment in time to track the payload the following day.

The United States' tracking station in Hawaii apparently made a signal pick up within 15 or 20 minutes of *Lunik's* launching at 70.2 megacycles when the space probe was still unidentified.

Astronautics Tests

Dec. 30—*Thor* off course shortly after launch was destroyed by range safety officer after 50 seconds of flight. Flight was the 30th firing of the *Thor* vehicle and the 24th of the *Thor* IRBM type.

Jan. 2—*Lunik*, Russia's space probe, launched shortly before noon. Burn-out velocity was approximately 24,500 mph. Arrived 4660 miles from the surface of the moon at 9:59 P.M. (EST) and proceeded on to an orbit around the sun. *Lunik* will reach perigee (perihelion) on Jan. 14 of 15-month orbit. Apogee will be approximately 214.75 million miles from the sun on Sept. 9, 1959.

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USSR Lunar Probes Will Orbit Close to Surface

by LCDR John A. Fahey, USN*

WASHINGTON—The Soviet Union has revealed detailed plans for future inspection of the moon's surface. In order to efficiently cover the entire surface of the moon, the Russians will attempt to establish a polar orbit.

Since the orientation of the moon's plane of motion in relation to the sun remains constant, using sunlight the entire surface of the moon could be photographed in four weeks (a lunar month). However, Russian scientists expect that the use of "earthshine" (ten times more brilliant than moonshine) will permit completion of the project in two weeks.

In order to avoid gravitational influences of the sun and planets, Soviet scientists have planned orbits extremely close to the moon's surface. At a given altitude the velocity of a lunar satellite will be almost five times less than the velocity of an earth satellite. This factor will greatly facilitate inspection of the moon's surface.

At a height of 30 kilometers (18.6 miles) objects, 3.8 meters (12.5 feet) in diameter, could be distinguished with the naked eye. However there are certain disadvantages in establishing such a close orbit. A satellite at this altitude will be traveling more than 1600 meters/sec (5250 feet/sec, 3580 miles/hr), and the field of view at a given moment will be about 650 kilometers (404 miles). At this height an object on the moon's surface will remain within the field of vision for six minutes, 20 seconds. Increasing the altitude to 150 kilometers (93 miles) will result in a less detailed observation. An object would have to be 19 meters (62 feet) in diameter to be distinguishable, but the field of view will increase to 1400 kilometers (869 miles) and an object will remain in the field of vision for 15 minutes, 42 seconds.

Soviet data indicate an intention to orbit a lunar *Sputnik* extremely close to the surface of the moon. It is interesting to note that plans call for a supply of fuel in the *Sputnik* for controlling the orbit. Small speed changes will be used to alter an elliptical orbit, to change the plane of orbit, and to decrease the time of passage across the unilluminated surface of the moon.

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* *Head, Foreign Language Division, U.S. Naval Intelligence School, Washington, D.C.*

SOVIET LUNAR PROBE DATA

Characteristics	10 Kilometers	50 Kilometers
Velocity of orbit (meters per sec/feet per sec/miles per hr)	1,674/5,492/3,745	1,655/5,301/3,614
Decrease in velocity of orbit for each one kilometer (0.621 mile) decrease in altitude (meters per sec/feet per sec/miles per hr)	0.479/1.57/1.1	0.463/1.52—1.0
Radius of orbit (kilometers/miles)	1,748/1,086	1,788/1,110
Relationship of radius of orbit to moon's radius, (percent)	100.6	102.9
Circumference of orbit (kilometers/miles)	10,983/6,690	11,234/6,976
Angular velocity (angular seconds per sec)	198	191
Period of one complete orbit	1 hr, 49 min, 20 sec	1 hr, 53 min, 7 sec
Minimum duration of a *Sputnik* day	58 min, 24 sec	1 hr, 5 min, 5 sec
Relationship of duration of a *Sputnik* day to the period of a complete orbit (percent)	53.4	57.5
Maximum duration of a *Sputnik* night	50 min, 56 sec	48 min, 1 sec
Relation of duration of a *Sputnik* night to the period of a complete orbit (percent)	46.6	42.4
Minimum arc of orbit during which *Sputnik* in the shadow of moon	192°16′	207°10′
Maximum arc of orbit during which *Sputnik* in sunlight	167°44′	152°50′
Heavenly arc described by *Sputnik* as seen by an observer in the plane of orbit on the moon's surface	12°16′	27°10′
Length of spherical segment of moon visible from *Sputnik* (kilometers/miles)	372/231	824/512
Relationship of area of moon's visible spherical segment to surface of moon (percent)	0.286	1.398
Maximum duration of observation from a point on the moon	3 min, 42 sec	8 min, 32 sec
Acceleration of free fall in orbit (meters per sec^2/feet per sec^2)	1.60/5.25	1.53/5.02
Relationship of previous value above to the acceleration of free fall to the moon's surface (percent)	98.9	94.5
Minimum number of orbits required for complete coverage of the moon's surface	15	7
Angles between consecutive planes of orbit	12°1′	25°42′
Velocity required to change plane of orbit (meters per sec/feet per sec/miles per hour)	350/1,148/782	736/2,415/1,646
Total velocity required for accomplishing all changes of planes of orbits (meters per sec/feet per sec/miles per hr)	4,900/16,077/10,962	4,418/14,485/9,876
Minimum duration required for complete coverage of moon's surface	27 hrs, 20 min	14 hrs, 57 mins
Relationship of coverage of moon's surface to actual surface (percent)	160	169
Amount of excess velocity required to leave *Sputnik* for surface of moon (meters per sec/feet per sec/miles per hr)	3/9.8/5	12/39.4/27
Total velocity during descent from *Sputnik* to surface of moon (meters per sec/feet per sec/miles per hr)	1,683/5,525/3,765	1,703/5,587/3,810
Duration of descent from *Sputnik* to the surface of the moon	53 min, 30 sec	54 min, 31 sec

Detection Seen Possible by Star Occlusion

ACF technician proposes to AAS meeting that telescope be mounted to a space platform and stabilized by slaving it to three reference stars.

WASHINGTON—A telescope mounted in a satellite or space station would be used for long-range detection in a method proposed by H. Dubner of Avion Division of ACF Industries in a paper presented at a recent meeting of the American Astronautical Society.

The proposed method, described in a paper titled "Long-Range Detection By Star Occlusion," is based on the fact that an object moving in space must eventually pass between an observer and some stars.

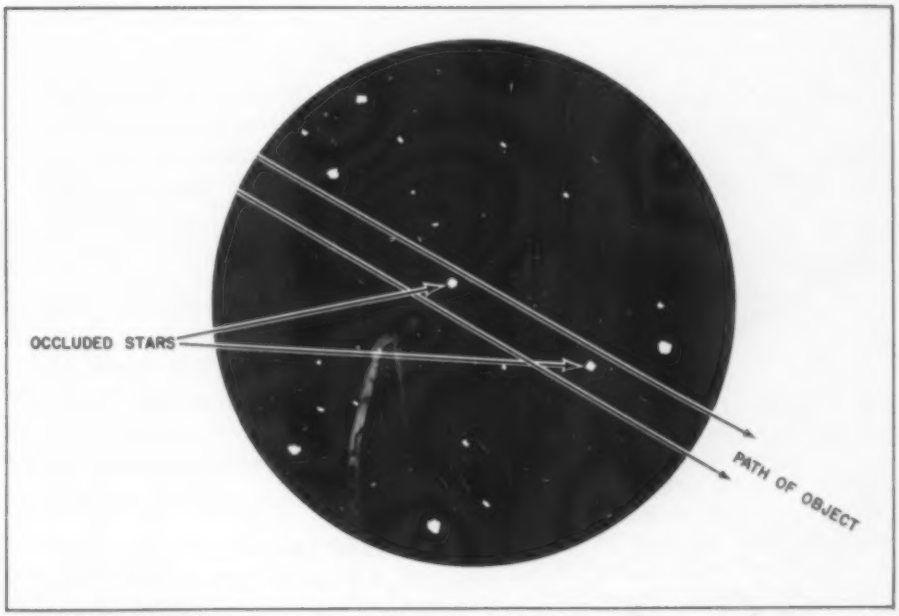
Dubner's method would use a telescope, a detector, a storage and comparator device, a clock and a computer. Since the computer would most likely be Earth-bound, a data link for telemetering would be necessary.

The telescope would be mounted on a space platform stabilized by slaving it to three reference stars. The view would be transferred from the telescope to a practical electrical outlet by an integrating image tube such as an image-intensifier orthicon. The output would then be stored for comparison with the following frame to determine occurrence and location of occlusions. Occlusion time and location then become an input to a computer which figures orbits and trajectories.

• **Stellar tripod**—For the telescope stabilization, the author proposes that a "stellar tripod" be used, with small telescopes focused on three reference stars as the tripod legs.

The telescope itself would be the 20-inch unit used by astronomers with a resolution of about 1/5-second. An f/1 concentric telescope is considered sufficient for desired resolution over large fields of view. The orthicon mentioned by Dubner is an RCA unit with a potential sensitivity six times as great as the human eye and a resolution of 100 lines/inch.

Using the case of a 10-foot object traveling at an orbiting velocity of



OBJECT MOVING in space eventually must pass between observer and star.

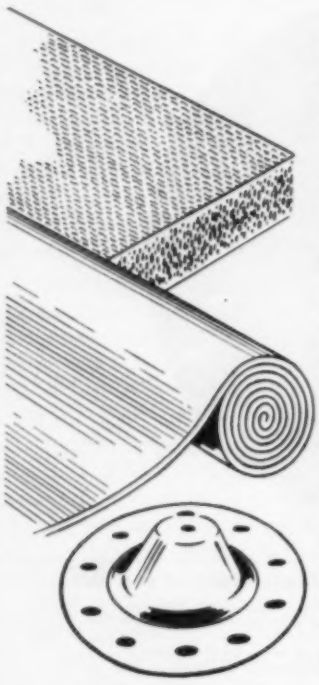
OCCLUSION TECHNIQUE ACCURACY

h = DISTANCE FROM EARTH	200 MI.	2,000 MI.
TIME FOR ONE REVOLUTION	91 MIN.	156 MIN.
MAXIMUM TIME ORBIT IS VISIBLE FROM EARTH'S SURFACE	9 MIN.	41 MIN.
TIME BETWEEN OCCLUSIONS	15 SEC.	26 SEC.
Δh DUE TO TIME ERROR OF .01 SEC. OF TIME	5.5 MI.	4.6 MI.
Δh DUE TO ANGULAR ERROR OF 1 SEC. OF ARC	2.33 MI.	3.33 MI.

ASSUMPTIONS: 1. CIRCULAR ORBIT AROUND EARTH
2. ONE STAR OCCLUDED PER DEGREE OF ARC

IN SILICONES OR RUBBER

WHAT'LL YOU HAVE?



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20,000 feet/second, Dubner figures occlusion time as 1/2000-second. For optimum sensitivity, he says, frame time should be about equal to time of occlusion indicating that more than one detector would be necessary.

The graph shows an example of data for two targets at distances of 200 and 2000 miles above the surface of the Earth for the conditions of two occlusions separated by 1 degree. Input errors of 0.01 second of time and 1 second of arc have been assumed. Orbit errors can be reduced by additional occlusions and the knowledge that the target is following ballistic course could be used to improve system sensitivity.

False indications of occlusion may occur at low signal-to-noise ratios, but if this occlusion is stored and compared with future occlusions it could be evaluated for validity. Dubner has developed a method of determining whether the occlusion is a false alarm or not and gives a derivation in the paper.

•**Limitations**—According to Dubner, two major limitations exist. Both are concerned with light; i.e., the wave character of light imposes range limitations, and the granular character of light imposes velocity limitations.

The range is limited because an object passing in front of a star does not cast a true geometric shadow—it forms a diffraction pattern. The smaller the object or the greater the distance to the observer, the larger the diffraction pattern, until finally the object cannot be discerned as occluding a star.

The velocity limitation is more serious, according to Dubner. Light from a star travels in the form of photons and the ability to detect a star is determined by the presence of a certain number of photons per second striking the detecting device.

Assuming that 16,000 photons/second enter the telescope aperture for the dimmest detectable star, if an object occludes a star for about 1/16,000-second, it would be difficult to determine whether the star has been occluded. In such an interval the chances are about 37% that a photon would not have arrived.

The detector itself creates further difficulties since it will not necessarily respond to each photon.

Dubner illustrates this with the example that the efficiency of the eye to sunlight is about 1% which means, he says, that about 100 photons are required to obtain a response from the eye. The orthicon has an efficiency of about 6 per cent.

Simplified Guidance Proposed

WASHINGTON—Two Sperry scientists believe that travel to the moon can be simplified by using a guidance system dealing strictly with Earth-vehicle and moon-vehicle problems on a two-dimensional basis.

The method, suggested by C. A. Brown and R. Fleisig of Sperry Gyroscope, was presented at a session of the American Astronautical Society during the convention of the American Association for the Advancement of Science.

In a paper titled "Simplified Space Guidance System Analysis," Brown and Fleisig discussed their procedure for estimating space guidance accuracy requirements and the results they had obtained.

Although the procedure would be useful for a wide range of space problems including interplanetary flight, the authors considered the moon as the objective in the specific applications presented.

• **The problems**—Two problems were considered: A vehicle launched from Earth and required to impact the moon; and a vehicle required to orbit the moon within prescribed altitude limits.

The method calls for a trajectory analysis to determine the sensitivity of guidance system parameters to variations in moon mission requirements and midcourse correction capability. For the impact vehicle, applications of auxiliary thrust at points between cutoff and the moon are made for trajectory corrections. The analysis seeks to determine the trade-off between guidance accuracy requirements and thrust requirements for corrections en route to and near the moon.

Brown and Fleisig assume that the three-body Earth-moon vehicle problem may, for present purposes, be simplified to Earth-vehicle and moon-vehicle problems. They make this assumption because only deviations from a nominal trajectory—rather than the specific trajectory itself—require great accuracy. Additionally, the three bodies are assumed to be coplanar, resulting in two-dimensional considerations throughout.

• **Simplified guidance**—The authors briefly describe the simplified guidance analysis procedure as follows: "Although the lunar trajectories are conic sections described by an ellipse or a hyperbola with the focus at the Earth center for the initial 215,000 miles of flight and a hyperbola with a focus at the moon center for the remaining portion, no trajectories are plotted and computations are made only for those points along the trajectory at which a switch in coordinate systems or a thrust correction occurs.

"The procedure for switching from earth to moon coordinates is simple as are procedures for incorporating corrective thrusts at midcourse positions. Using the methods described (in the main body of the paper), the total time required for an engineering aid to complete a single computation leading to cutoff velocity vector accuracies for the case of unpowered flight is approximately 10 hours."

The set of terminal conditions assumed by Brown and Fleisig are based on a dead center impact on the moon. Satisfactory error trajectories correspond to impact anywhere on the surface of the moon as indicated by two of the trajectories illustrated which just graze the moon's surface.

The authors also describe the means for reducing the amount of correction necessary and work out the means for a simplified analysis for the guidance necessary to hit or orbit the moon. Copies of the paper are available from the Sperry Gyroscope Company, Astronautics Section, Air Armament Division, Great Neck, N.Y.

1958 Electronic Sales Hits Record $7.7 Billion

WASHINGTON—The electronics industry, overlooked by the 1958 recession, ended the year with a new factory sales record of $7.7 billion—$100 million above the previous high in 1957.

Industry economists predict that the 1959 sales peak will reach $8.3 billion.

Major reason for the boom, according to the Electronics Industries Association, is the military change-over from aircraft to missiles, which require more extensive and subtle electronics systems.

In its year-end review, EIA says military electronic equipment sales passed the $4.1 billion mark and represent well over half the total dollar volume.

EIA predicts that the emphasis on missiles will add further to the electronic industry's sales to the military in 1959. Total military electronic expenditures in 1959 are expected to rise to $4.4 billion.

Industry passed the consumer market in 1958 as the second largest buyer of electronic products, EIA reports, topping $1.4 billion for the year. Computer and data processing equipment represented the largest single items on industry's purchasing list.

Industry sales in 1959, EIA predicts, should continue to rise and probably will reach $1.5 billion.

The long range picture for the electronics industry, according to EIA, shows unlimited growth, with new industrial segments such as nuclear instrumentation and telemetry added to the fast-growing family of electronic products.

Sperry Develops New Flotation Fluid

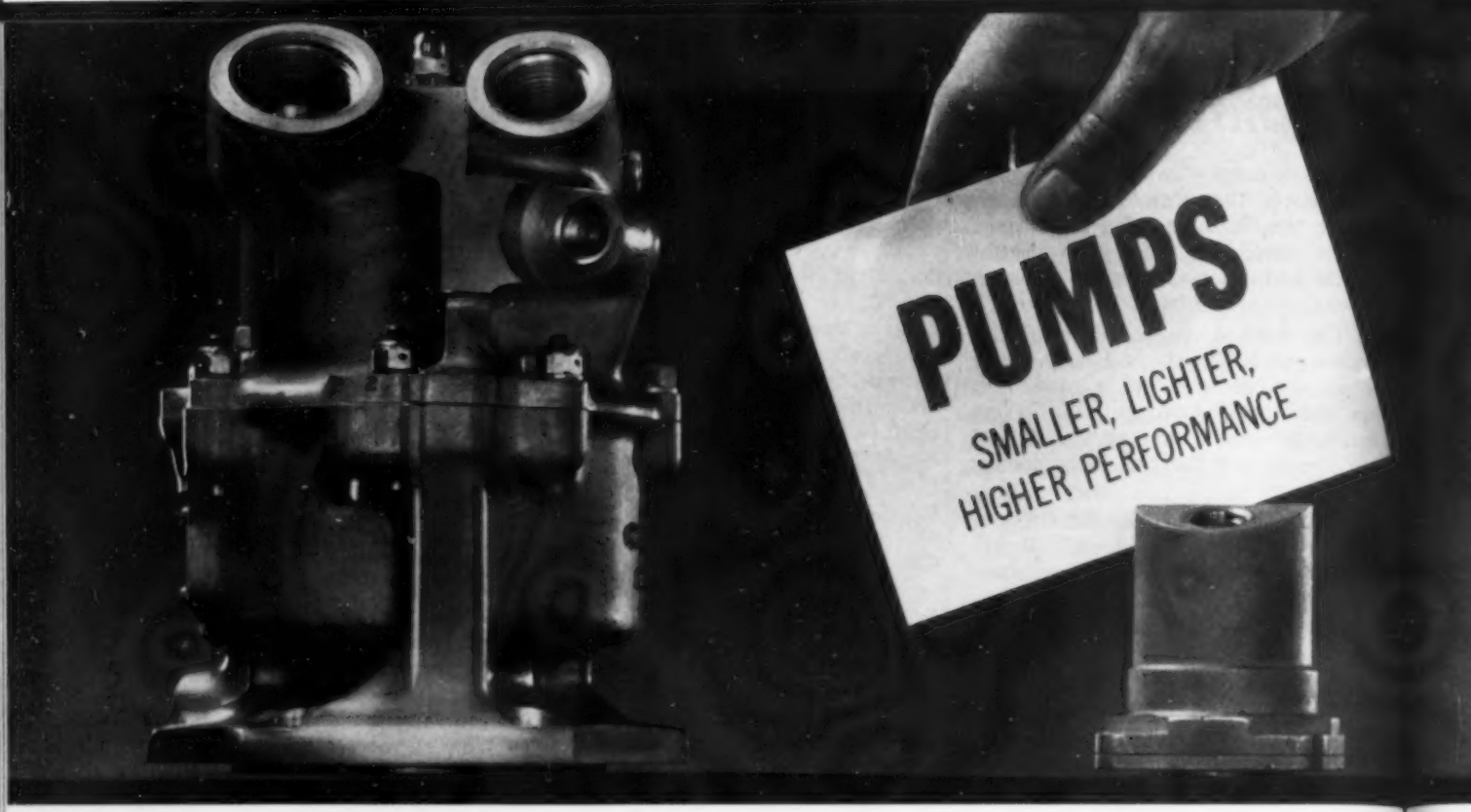
WASHINGTON—The Air Force has announced that Sperry Gyroscope has developed a new floatation fluid which might revolutionize the manufacture of fluid-floated gyros.

Company chemists, turning away from the chloro-fluorocarbon fluids generally used, devised a bromine version of the same class of compounds. The new fluid reportedly remains viscous to less than –65°F without artificial heating.

Because it remains viscous and never solidifies at low temperatures, it can be brought up to operating temperature very quickly without the damage hazard inherent in other floatation materials.

Conventional gyro fluids have always had the disadvantage of starting to solidify at temperatures not much below operating conditions. Hence, most fluid gyros are brought up to temperature in final test and kept that way throughout their service life. If the gyro heater fails in the sub-zero temperatures encountered in missile flight, the fluid can become so hard that it shatters into fine particles, damaging or occasionally severing the thin electrical leads that pass through it and

TESTING FLOTATION fluid.



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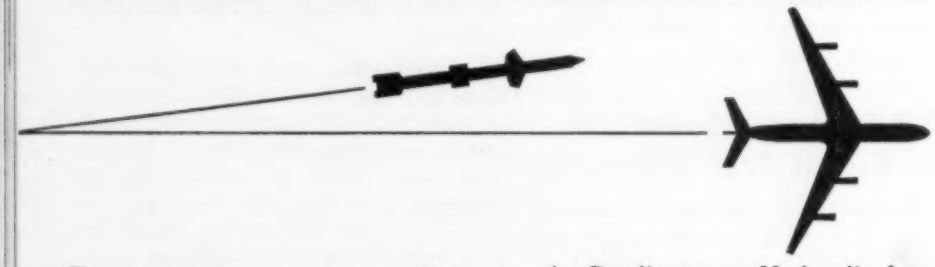

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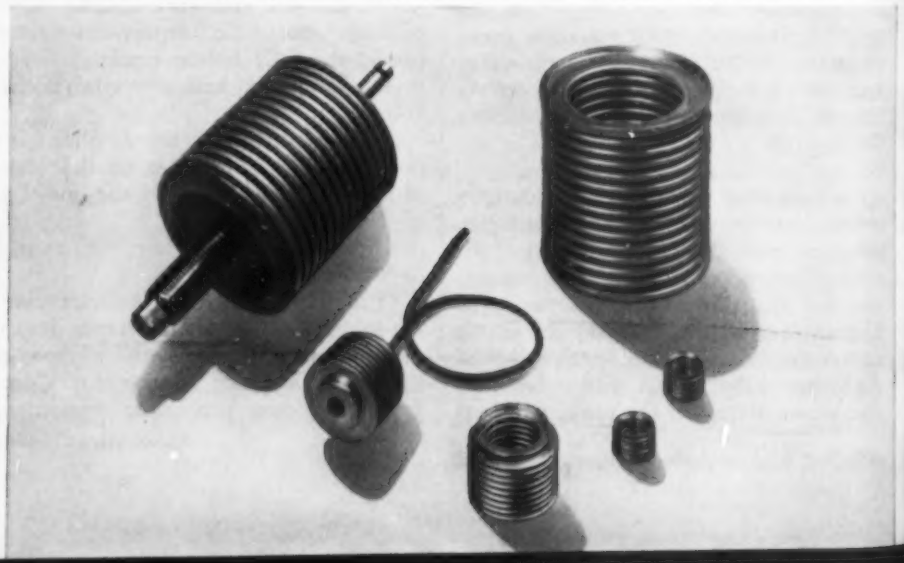

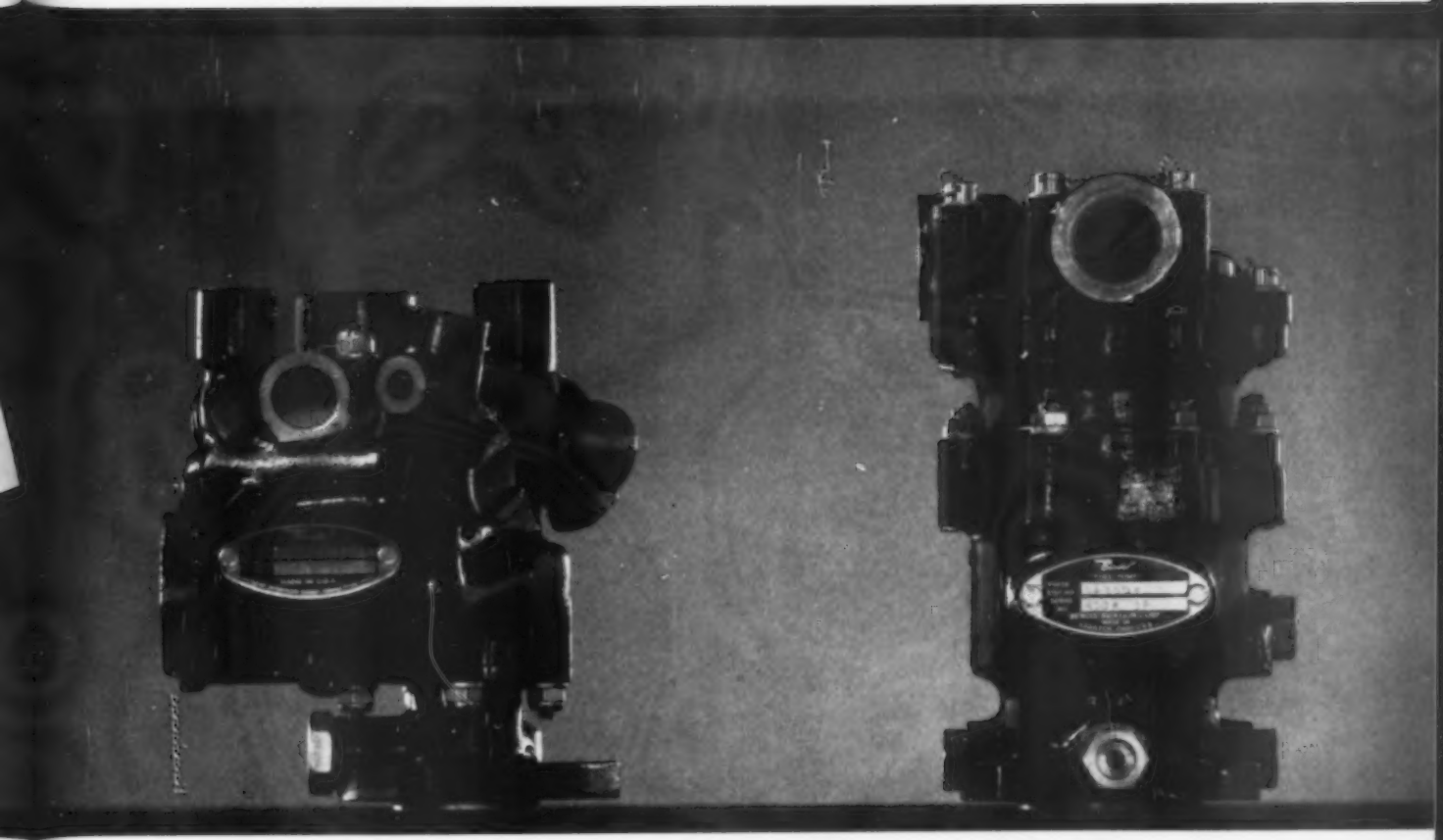

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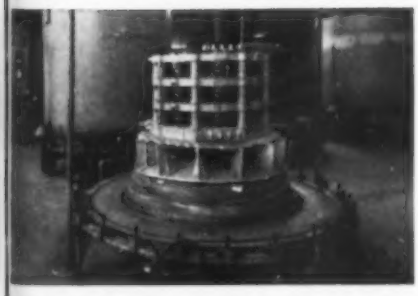

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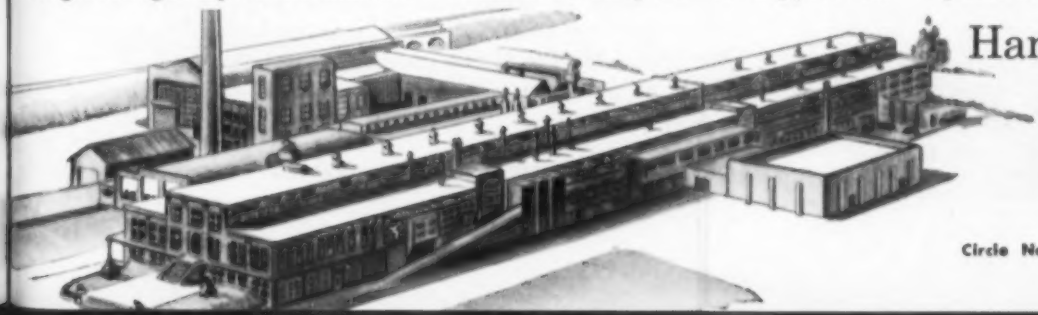
Lapping operations hold flat surfaces within one light band when checked with an optical flat. Grinding and honing departments continuously maintain tolerances as low as five millionths of an inch on production work.

The specialized engineering and production test facilities offered to any Bendix Hamilton customer are complete to develop and produce equipment to the most exacting requirements of the aircraft and missile industries. They assure a quality end item manufactured and tested to your specifications.



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STRIKE OF THE HAWK!

RAYTHEON-DESIGNED Hawk missile annihilates radio-controlled F-80 jet fighter at 500 ft. altitude.

ARMY'S HAWK MISSILE is fired from mobile launcher. Missiles, launcher and support equipment can be air-lifted or quickly transported by Army or Marine ground forces.

NEW ARMY MISSILE DESTROYS LOW-FLYING AIRCRAFT

This *proven* anti-aircraft missile operates even at tree-top heights, in the blind zone of other radar-controlled missiles.

Raytheon is prime contractor for the U.S. Army Hawk weapon system—now in production and slated for use with fast-moving Army and Marine Corps ground forces as well as for the defense of U. S. cities.

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Excellence in Electronics

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conduct power to the gyro wheel.

Sperry chemists say the new fluid maintains its plasticity at less than -65°F without artificial heating. Viscosities and densities can be easily adjusted to meet a wide variety of gyro operating requirements.

Although the fluid was developed in connection with Sperry's B-58 Hustler bombing-navigation system, future uses will probably center around missile and space vehicle navigation systems. Freedom from the requirement for continuous heat on gyros and gyro accelerometers will be a considerable aid to inertial system designers.

GE Uses 'Woofers' To Test Components

PHILADELPHIA—The world's most powerful hi-fi woofers (speakers) are being used by the missile industry to test components.

Highly intense noise, provided by random noise generators and amplified to an ear-splitting 145 decibels by three 600-watt loudspeakers, is used by General Electric's Missile and Space Vehicle Department to test missile and space vehicle components.

Extreme vibrations set up by these noise levels approximate those produced by rocket and jet engines. To insure components against failure caused by noise vibration, aircraft and missile manufacturers can use such noise devices for preliminary tests in the laboratory.

At GE's Missile and Space Vehicle Department, three 600-watt loudspeakers blare into a 120-cubic foot chamber, whose seven walls are out of parallel alignment.

General Electric has used this facility to test the nose cone electronic components—amplifiers, recorders, and other noise-sensitive devices—before they are installed in the nose cones for *Atlas* and *Thor* missiles which the company is developing for the Air Force. By allowing the noise to flow into a 3150-cubic foot room, a complete nose cone can be tested.

Temco Develops TV Surveillance System

DALLAS—An airborne television surveillance system has been developed by Temco Aircraft under contract from the Navy, which is now evaluating it at Patuxent River Naval Air Station, Maryland.

Although the system, called "Alpha," was originally designed as a means of missile terminal guidance, the present evaluation is also considering reconnaissance work.

Aerodynamically, test models of the Alpha resemble a small missile in shape, 8¼ inches in diameter and 105 inches long. In terminal guidance, the Alpha returns an image of the terrain to a central control station. As the weapon using Alpha closes on the target, the course is guided by radio signals transmitted by an operator watching a television receiver in the master control station many miles away.

This system might be planned for use in the newest version of the Navy's *Bullpup*, which will use a packaged liquid-fuel engine, a nuclear warhead, and an "improved" guidance system. The USAF reportedly will use similar features on its upcoming *White Lance*.

During the evaluation, television information relayed by Alpha is being fed into a video tape recorder manufactured by the Minnesota Mining and Manufacturing Co. The recorder permits immediate review of television information recorded during flight, eliminating time lost for film development.

As a reconnaissance system, the in-

Today artificial satellites orbit in space. Missiles can span continents. Conservative scientists calmly talk of landing on the moon.

Just as they have contributed to other aeronautical sciences, the various divisions of United Aircraft Corporation have made significant contributions to these new fields of missiles and space technology.

Recently the outstanding scientists and engineers who had specialized in missiles, missile guidance and space penetration problems in each division were brought together to focus their combined skills on advanced concepts and systems. A new Division was created . . . the Missiles & Space Systems Division.

This division is only weeks old. It is in an explosive growth period. Yet it has a built-in stability factor . . . the advantages of the brainpower, the "know-how", the financial resources and the unique facilities of a billion-dollar corporation that is already preeminent in aeronautics.

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formation pictured by the TV conceivably could be recorded on the video tape recorder and triggered for transmission to earth when the satellite or vehicle was in a favorable transmitting area.

New Space Testing Lab. Opened at Newton, Mass.

NEWTON, MASS.—NRC Equipment Corp., a subsidiary of the National Research Corp., has formed a new engineering and sales groups to handle its space testing facilities.

Vice-president and general manager James H. Moore said the new departments will assume all-over responsibility for ultra-high altitude test chambers, vacuum pumps, vacuum instrumentation and related accessories, and environmental facilities for testing men, materials and products in space.

Moore said that most of NRC's present facilities are limited to simulating altitudes below 100,000 feet, but that more sophisticated equipment would be designed for higher altitudes "as we learn more about outer space."

NRC already has some non-classified equipment which simulates higher altitudes, including a number of chambers which test components under pressures and temperatures up to 300,000 feet, and some smaller facilities for creating pressures equivalent to altitudes approaching 400 miles.

Fiberglass Astrodomes

WEATHERPROOF ASTRODOMES are being used to protect instrumentation, motion picture cameras, telescopes and other equipment used in tracking missiles. Manufactured by the Houston Fearless Corp., the astrodomes are made of impregnated honeycomb covered with fiber glass.

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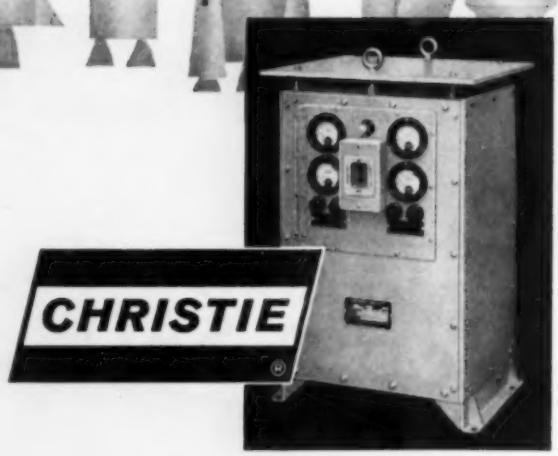
D-C POWER



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moscow briefs

The rise in U.S. rocket and missile production is noted in Krasnaya Zvezda, official organ of the Soviet armed forces.

In his article, "Problems of Struggle for Domination in the Air," Maj. Gen. G. Pshenianik writes that while in the 1953-54 fiscal year, American "expenditures for rocket weapons were $504 million, or about six % of the sum spent on the purchase of military aircraft. In the 1957-58 fiscal year such expenditures amount to more than $2.5 billion or more than 35 % of the sum allotted for the purchase of military aircraft."

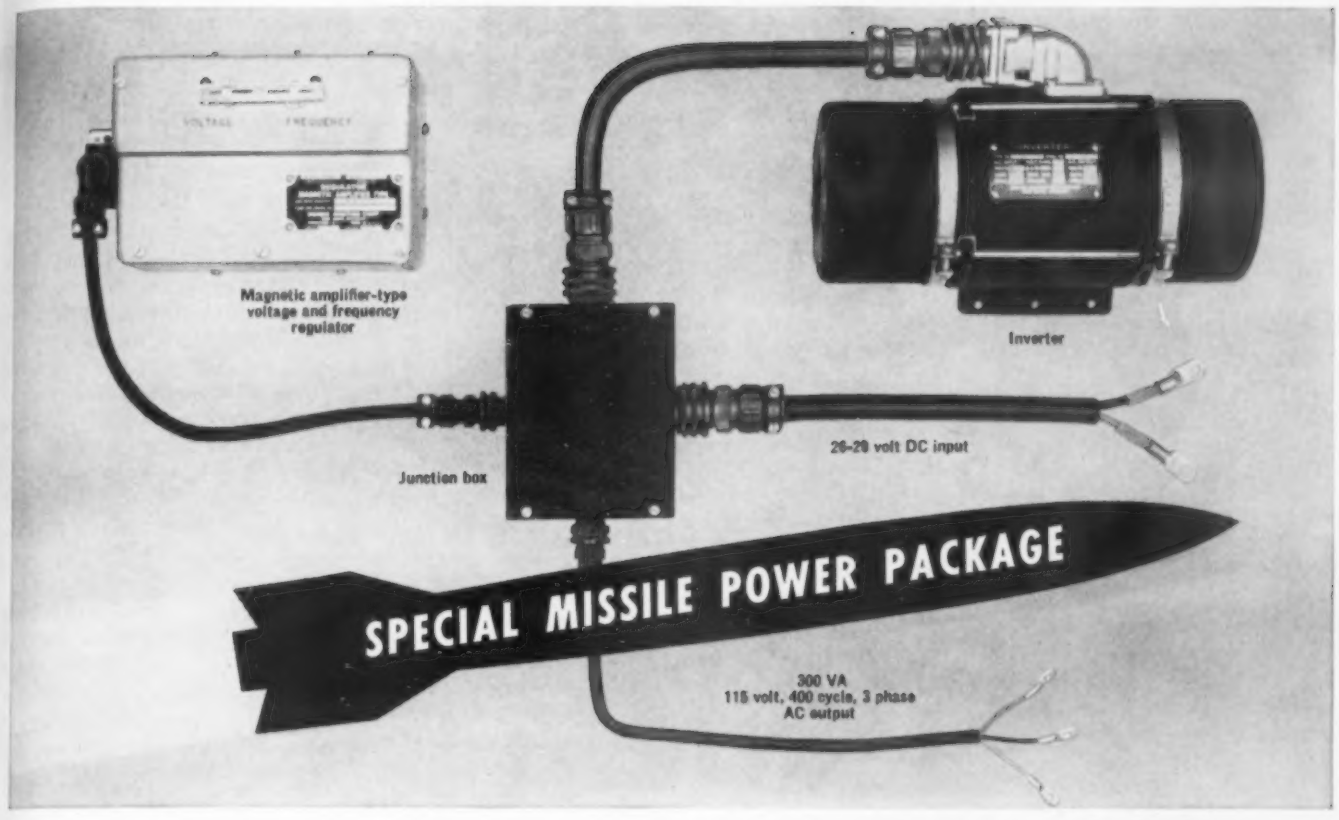
Gen. Pshenianik concludes: "The leading military circles of the USA continue to place their main trust in the forces of military aviation, particularly in strategic aircraft and rocket weapons."

The author of this article is not only an air force general but also a scientist with the degree of candidate of the military sciences.

Commenting on current reorganization of U.S. armed forces, Lt. Col. Ye. Makhov writes in Sovetskaya Aviatsia that "out of the eight newly confirmed American commanders, four are air force generals, three are admirals, and only one is an army general." Makhov's article, entitled "The Structure is New but the Policy is the Same," stresses the importance of "strategic aviation, this chief weapon of threats and blackmail in the hands of American imperialists."

How can man hold an artificial satellite at a necessary height a longer time than he can now? In Znanie—Sila, author M. Astrov answers: "Very simply—by supplying the satellites with means of motion. Since the resistance of the atmosphere at 100-200 kilometers above the Earth's surface . . . is very small, the motor force needed to overcome this resistance will also be quite small. Such motor-furnished *Sputniki* will be 'sky auto-cars,' so to say. To distinguish them from satellites let us call them satelloids."

The world's largest electromagnet to study cosmic radiation is claimed by the Soviets. The Moscow *Trud* reports the equipment is installed at the Aragats High-Altitude Station of the Physics Institute of the Soviet Armenian Academy of Sciences. The newspaper adds that a still more powerful electromagnet for the same purpose (and also for the work of Armenian physicists) is being built in



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MISSILE INVERTERS—400 CYCLE OUTPUT
(Incorporate Static Type Controls)

Type	Input		Rated Output			Max. Altitude at Rated Output	Approx. Wt. Lbs.	Designed to Gov't. Part No.
	Volts	Amps.	Volts	Phase	VA Rating			
32B92	27.5	126	115	1 3	1500 1800	20,000	37	—
32B81	27.5	100	115/200	3	1500	Unlimited	65	—
32B77	27.5	180	115/200	3	3000	Unlimited	75	—
32B79	27.5	400	115/200	3	7000	Unlimited	115	—
32B76	27.5	20	115	3	500	70,000	25	—
32B122	27.5	150	115/200	3	2500	50,000	65	—
32B41	27.5	150	115/200	1 3	2500 3000	50,000	68	—
32B52	27.5	35	115/200	1 3	500 500	40,000	25	—
32B106	27.5	95	115	3	1400	35,000	44	—
32B27	27.5	285	115/200	1 3	3500 4000	50,000	76	—

GENERAL PURPOSE INVERTERS—400 CYCLE OUTPUT

Type	Input		Rated Output			Max. Altitude at Rated Output	Approx. Wt. Lbs.	Designed to Gov't. Part No.
	Volts	Amps.	Volts	Phase	VA Rating			
12128	27.5	1	26	1	6	35,000	2.2	AN3496
12126	27.5	2	26	3	10	35,000	2.3	E1615
MG-54	27.5	22	115/200	1 3	250 250	50,000	17	E5109
12142	27.5	22	115	1 3	250 250	35,000	13	E1617
12143	27.5	22	115	3	250	35,000	13	—
32E01	27.5	35	115	3	500	50,000	26	AN3533-1
32E00	27.5	51	115	1 3	500 750	50,000	34	AN3534-1
MG-65	27.5	52	115/200	1 3	750 750	50,000	35	E52805-2
MG-61	27.5	126	115	1	1750	50,000	54	53C6767
1518	27.5	126	115	1 3	1500 1800	20,000	37	—
32E06	27.5	160	115/200	1 3	2000 2250	50,000	56	E1725
32E03-3	27.5	150	115	1	2500	50,000	58	53B6227
32E03-9	27.5	160	115/200	1 3	2500 3000	50,000	58	E54807
32E09	27.5	160	115	1 3	2500 3000	50,000	60	—

Red Bank Division — Bendix Aviation Corporation

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Qualified physicists, mathematicians and electronics engineers should investigate a future by the ocean with Pan Am. Please address a confidential resume to Mr. C. R. Borders, Assistant Division Technical Manager, Pan American World Airways, Inc., Patrick Air Force Base, Cocoa, Florida, Dept. B-2.

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. . . moscow briefs

Leningrad. This machine will be installed in the little town of Nor Anberd in the Ashtarak Region of Armenia, 2,000 meters above sea level.

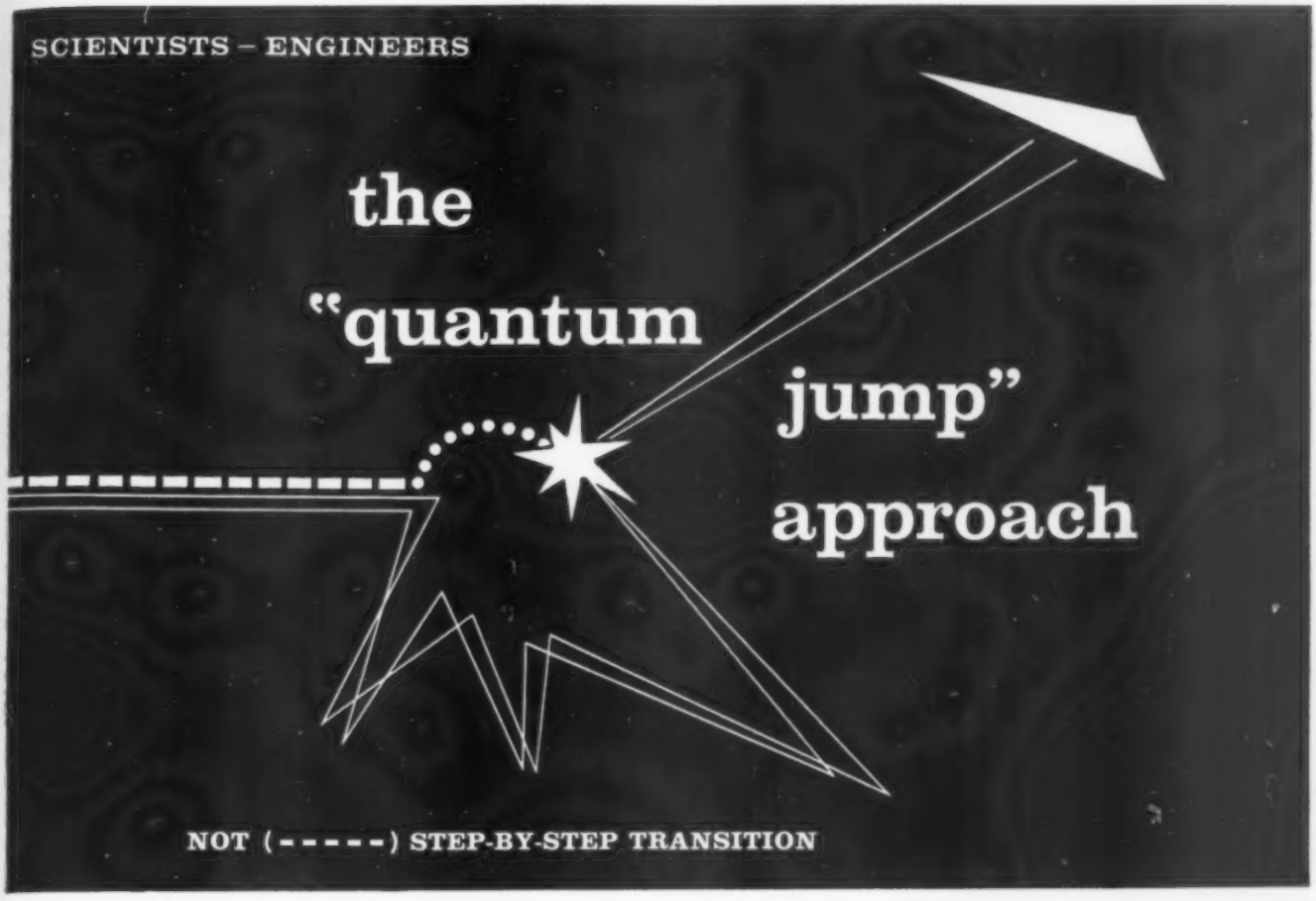
A system of automatic functioning for a large modern telescope has been worked out by a group of Soviet scientists at the Institute of Electromechanics of the Academy of Sciences. Yu. Sabinin, a candidate of the technical sciences, was in charge of the project. The system, installed at the Crimean Astrophysical Observatory, allows an observatory to leave its telescopes unattended, yet obtain photographs and other records of satellites, stars, comets or other celestial phenomena.

The easternmost *Sputnik*-tracking station in the Soviet Union is on the island of Sakhalin. The Soviet news agency TASS reports that the station is functioning at Yuzhno-Sakhalinsk, in the island's southern part, and is attached to the department of physics at the local teachers' college.

Conquest of outer space was the special theme of the celebration of the 41st anniversary of the Communist seizure of power in Russia. Soviet "cosmic decorations" dominated Moscow displays of the holiday. Full-sized models of the three *Sputniki* were hoisted over Gorky Street, the Red capital's main thoroughfare. The multitudes marching past Premier Khrushchev and his cronies on the Red Square reviewing parapets, carried posters, banners, and other exhibits showing Soviet rockets, missiles, and *Sputniki*.

Khrushchev showed his delight when the model of a space ship of the future, a gas-filled balloon dubbed the "Moon Rocket," was brought into the square by Soviet athletes dressed in star-spangled cloaks. When the "Moon Rocket" was released to float above the Lenin-Stalin mausoleum, Khrushchev, standing on the mausoleum's roof, was seen to follow the balloon's flight with great animation.

The first Polish rocket is reported by *Sovetskaya Aviatsia*. It was made and recently launched in the Blendov Desert in Poland by the Cracow branch of the Polish Astronautic Society, in collaboration with the Rocket Section of the Ore and Metallurgy Academy in Cracow. The aim of the rocket launching was "meteorological and other researchers in the upper strate of the atmosphere." The rocket is described as 820 mm. long and 63 mm. in diameter.



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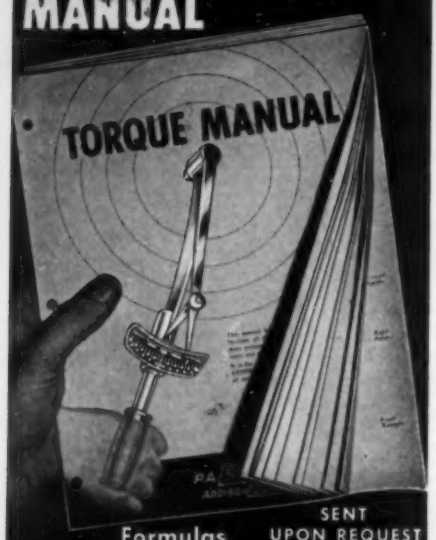

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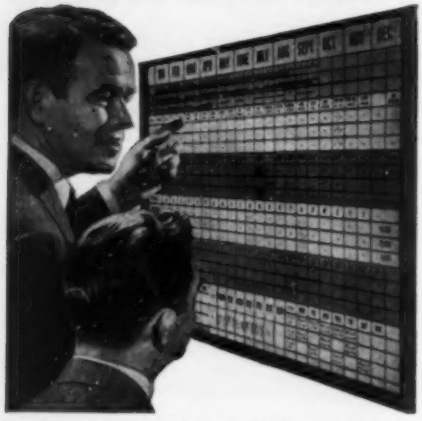

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soviet affairs

by Dr. Albert Parry

A few weeks before the launching of the *Atlas* satellite, Soviet astrophysicist Prof. V. V. Dobronravov recalled that following *Sputnik I* some American scientists said their country's "much-touted technology" could catch up with Soviet technology in two or three years. Others said it might take 10 years. Wrote the Russian savant in *Komsomolskaya Pravda*:

"Far be it from us to deprecate the potentialities of American science and technology and the knowledge and experience of American scientists and engineers (who, at that, readily avail themselves of the help given them by specialists of non-American origin). But the results of the year which has just passed show that the lag not only has not diminished but, on the contrary, has grown wider. With each day it is more and more difficult for Americans to catch up with us."

As the year approached its close, Soviet boasts continued. In the official newspaper of the Soviet armed forces *Krasnaya Zvezda*, Col. I. Verov reported that whereas in the 103 years from 1814 to 1917 only 36,078 inventions were patented in tsarist Russia, in just one year of 1957 more than 2 million inventions and technical improvements were recorded in the Soviet Union.

Occasionally, however, the Soviets do admit slowness in some fields of space-age engineering. In the computer realm, for instance, things are not as they should be. It is true that from 1950 to 1957 Soviet production of computing machines increased 17.6 times, and computer experts in that country are now being trained at the rate of several hundred annually. A new institute of mathematics, with a computing center, is being organized at Sverdlovsk in the Urals. But Russia's rocket and missile experts cry, "Not enough!"

In London recently, visiting Soviet Prof. A. P. Yershov, head of the theoretical programming department of the computer center of the Academy of Sciences, revealed that his staff lacks a system which would enable it to feed problems into computers without stopping to code them. Western mathematicians have a similar need, but the Russians may be worse off. Besides their usual Greek symbols, they sometimes complicate matters by trying their own Cyrillic as well as a synthetic language rigged up by computer specialists.

Expansion or computer-making and other electronic manufacture is now noted in other Red countries. Red China reports it is producing computers and other machines including "telescopes which register the intensity of cosmic radiation" and "various counters used to ascertain types, energies, and power of different radiations." With Kremlin permission, Poles are building their first small rockets with electronic ingredients. And East Germans are being entrusted with production of electronic components for Russia's *Sputniki*.

Strong winds on Mars are raising clouds of dust and sand, states Prof. V. Sharonov, in charge of the astronomical observatory at the University of Leningrad. He calls this phenomenon "an important event" and explains it by the influence of sun spots "upon Mars no less than upon our planet."

west coast industry

by Fred S. Hunter

The chips keep getting bigger all the time in the weapons-systems game as it is being played these days. A Douglas engineer, asked how much his company may have spent in preparing the proposal it submitted in the competition for assembly and test of *Minuteman*, made this off-hand reply: "Oh, about half a million dollars." This seems an astronomical figure, but a lot of man-hours are involved in taking an idea from an original concept, creating the design, setting up the complete technical data on feasibility manufacture, test, quality assurance, reliability, maintenance, service and supply. It takes from eight to twelve weeks to put together a proposal on a big job. Moreover, you can't use second-rate talent in the preparation of proposals or you'll never win one. So figure $15,000 a year as the average salary scale and your estimate will be fairly close. We've heard that Boeing is using 200 engineers in working up its bid on *Dyna-Soar* while 300 were used on *Minuteman*. Add other costs, such as travel, communications and the printing of all the fancy material and it is easy to see how the cost of preparing a bid on a development contract may come to as much as the fee you'll get if you win it. Smaller companies, bidding on subsystems, have cost problems in the same ratio as the big producers. For example, it cost Daystrom Pacific around $12,000 to prepare a recent proposal for a black box about half the size of the telephone handset on your desk.

Lee Stockford, corporate industrial relations advisor to Lockheed Aircraft Corp., warns of an impending serious shortage of young executives in the 35-to-40 year age bracket. It will come in about 1966. Stockford uses simple arithmetic and birth rate statistics to reach his conclusions. More than 4,200,000 children were born in the U.S. in 1955, but only 2,200,000 in 1940. The latter crop will be reaching 35 in 1966. From then until about 1977 there's going to be a shortage of bright young men. Management will be smart to plan now to push their young executives along a little faster and establish a policy of retaining retired executives in consulting capacity, Stockford advises.

Two of the *Polaris* test projects at Lockheed Missile Systems Division have the delightfully descriptive names of *Pea Shooter* and *Sky Hook*. But the one we really like is *LUMF*. It sounds as though Bert Lahr were pronouncing it. It means, as you might easily deduce, Lockheed Underwater Missile Test Facility. It's a tank for launching tests of scale models of the *Polaris*. The tank is 24 feet deep, which may or may not be a hint of the depth from which *Polaris* missiles are to be launched; the launching cradle is powered to move across the tank to simulate the forward speed of a submarine, and a "wave generator" (so named by the Navy) whips up waves to four feet high. Eight cameras, six under water, record all shots, although not all are trajectory tests. Lockheed averages four scale-model tests a day in the tank, or more in one day than in a week with full-scale models in the ocean.

The Navy is conducting classified studies of ocean currents and temperatures with an eye to use in antisubmarine warfare at its Ferndale Oceanography Station north of San Francisco. Newly developed electronic gear is said to furnish more accurate data than previously available. Long plagued by erratic sound wave transmission characteristics by underwater temperature "layers," the Navy is reported to be using much high-intensity sound generating equipment in the studies.

Howard L. Richardson, senior vice-president-Electronic Systems for Sylvania Electric Co., on a West Coast trip, indicated few changes will be noted in the company for some time after the merger with General Telephone Co., "but the merger will give us a chance to seek larger military orders than we have in the past."

Military reliability in

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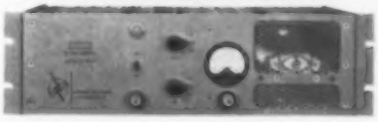
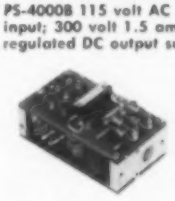


PS-4000B 115 volt AC input; 300 volt 1.5 ampere regulated DC output supply



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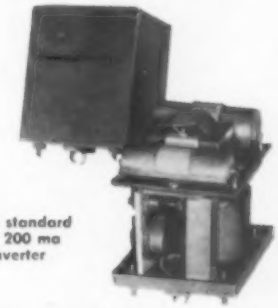

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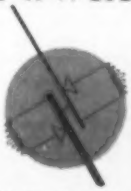

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Write for Bulletin AV2010 on Bristol Miniature Gage and Absolute, Adjustable and Differential Switches. The Bristol Company, Aircraft Components Division, 173 Bristol Road, Waterbury 20, Conn. 8 44

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Burst Pressure – exceeds 250% of normal working pressure

Electrical Ratings – 5 amp at 125 v, 60 cycle, inductive or resistive
4 amp at 30 vdc resistive
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Dielectric Strength – 500 v rms between terminals and from terminals to case (MIL-S-8801)

Life at Rated Electrical Load – 40,000 cycles at 125 vac
25,000 cycles at 28 vdc

High Temperature Exposure & Operating – (MIL-S-8801) 250° F

Low Temperature Exposure & Operating – (MIL-S-8801) −65° F

Shock, 30 g, 3 axes – (MIL-S-8801) no change

Vibration – (MIL-S-8801) no contact chatter, no switch damage
300-600 cpm at 0.050" d.a. – set point change – none
operating differential change – none
600-4500 cpm at 0.036" d.a. – set point change – ¼ psi
operating differential change – ½ psi
4500-30,000 cpm at 10 g – set point change – ¼ psi
operating differential change – ½ psi

Diameter – 1-5/16

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book reviews

METALS FOR SUPERSONIC AIRCRAFT AND MISSILES, D. W. Grobecker (Ed.), American Society for Metals, 1958, Dept. A, 7301 Euclid Ave., Cleveland, 432 pp.

This is a compilation of technical papers presented at the Conference on Heat Tolerant Metals for Aerodynamic Applications held January 28-29, 1957 at the University of New Mexico.

It covers the entire field of aerodynamic and thermodynamic heating currently encountered by aircraft and missiles metallurgical studies involved in the high-temperature environment produced by the vehicles in flight.

Since the presentation of the papers was almost two years ago, some of the problem areas discussed by the authors probably do not exist at the present time. Still, the conference proceedings which were published this year emphasize many exacting environmental barriers that will have to be faced in the months and years to come and the need for intensive research in materials.

The papers presented generally conclude that:

1) The aerodynamic and thermodynamic problems cannot be solved by metals alone, even the rarer metals. The design limitation on material weight must be compromised as the needs for heat resistance increases.

2) It will be necessary to insulate a high-strength internal structure with a high-heat resistance shell. Composite materials, consisting of coatings and laminations of metals and nonmetals must be employed.

3) Cermets offer great promise because of their strength, hardness, and heat resistance in addition to providing new ways to apply basic solid-state physics and chemistry to the production of new materials.

4) Materials research must be coordinated along with structural and aerodynamic development.

5) More basic research and development is needed within the metals industry including the broader field of solid-state physics, chemistry, ceramics, and surface chemistry.

Goal for achievement, the authors specifically concluded, should aim at providing the Air Force with those materials of which it has dire need, including molybdenum alloys for withstanding increases in speed from Mach 3 to Mach 7 and rocket nozzle materials with increased life at flame temperatures of 4000 to 5000 degrees F, which would increase range 400%.

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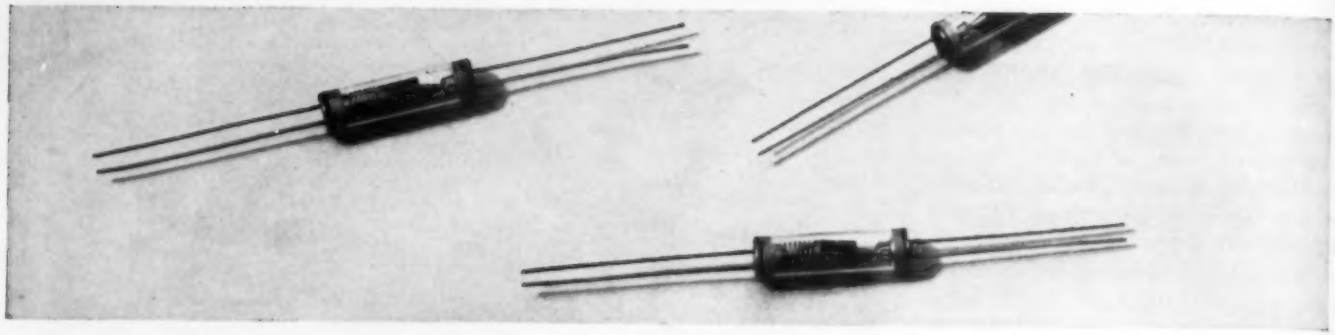
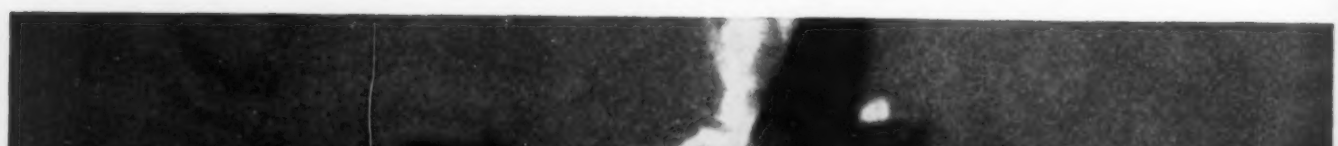


FOR RELIABILITY



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letters

Mars and Venus Probes

To the Editor:

As a regular reader of your fine magazine I was somewhat surprised by two statements made in your November 24 issue. I consider these statements to be erroneous.

One statement on page 13 indicates that a "minimum energy" Mars probe will occur around March 1, 1959. A "minimum energy" Mars probe can start around August, 1960 because such probes should start not 247 days ahead of a conjunction but 96 days ahead of an opposition. For Venus the favorable starting day is around June 1, 1959, 87 days ahead of an inferior conjunction rather than 151 days before a superior conjunction.

The other statement on page 28, says ". . . it would arrive in the vicinity of the moon at the conjunction and if it passed the moon it would proceed on into the sun instead of an orbit around it." This violates elementary laws of celestial mechanics. We will never shoot into the Sun, unless we are able to obtain a velocity change of over 70,000 mph., three times as much as the present moon-shots. In all other cases the rocket, if escaping the gravitational fields of the earth and the moon, will go into an orbit around the sun which may be more or less elliptic and have a period of more or less than a year. Shooting "straight into the sun" would tend to make the orbit time close to one year and the rocket would return into our vicinity after that time.

I realize that your publication has a drastic deadline problem which makes it difficult to check technical and scientific statements which are to appear. Yet I am sure that this must be done if the excellent standards which you have set are to be maintained—and upon which your readers depend.

Herman F. Michielsen
Research Specialist
Lockheed Aircraft Corp.

We stand corrected. A payload shot in the direction of the moon, when it is in conjunction, would not travel on to an impact with the sun if it missed the lunar body. Through the use of vector analysis it can be shown that an object fired directly at the sun with a maximum velocity of seven miles per second from the earth, which is traveling around the sun with a tangential velocity of about 18 miles per second, would travel in an elliptical orbit quite similar to earth's orbit with a maximum velocity about the sun of approximately 20 miles per second.

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If you would like to join the personnel of the Advanced Engineering Department in satisfying work at the frontiers of knowledge in these areas, there are opportunities for men with the following experience:

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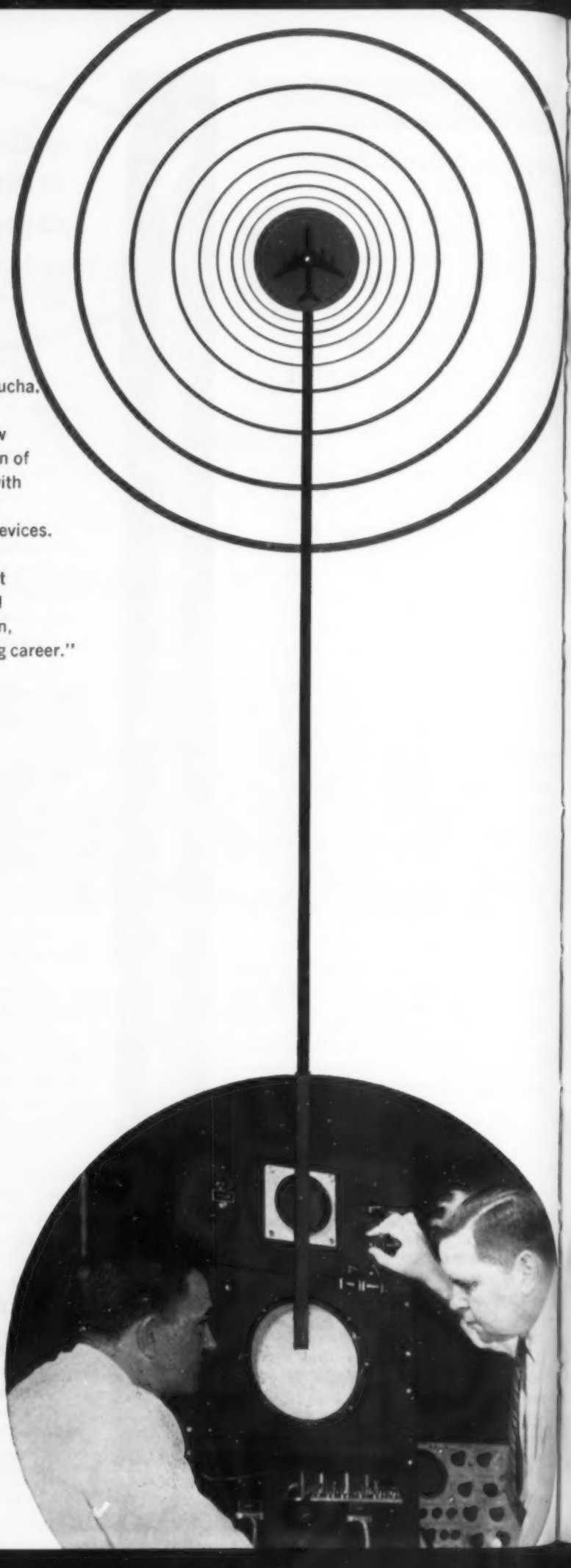

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SYSTEMS ENGINEER to design and analyze closed-loop systems of inertial and radar equipment, display materials, and computers.

Qualifications: Bachelor's or advanced degree in E.E. or Aeronautical. At least 2 years' experience in systems analysis. Additional experience desired in development of military devices—servomechanisms, radar or computers.

704 PROGRAMMER ANALYST to study data flow diagrams and write differential equations of a circuit diagram. To investigate analog and digital real-time control systems using digital and/or analog computer.

Qualifications: M.S. in Physics and 2 years' experience in control systems analysis and/or shielding techniques. Must know transforms, numerical analysis, and be able to construct mathematical model of a reactor.

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. . . letters

Real Reason

To The Editor:

Your recent editorial on education has some constructive suggestions. But along with so many others writing on the subject, you have apparently missed the real reason for our technological dilemma.

Many high school students believe that a scientific career is too difficult for the compensation received. Notice that it is not that it is too difficult, but that it is too difficult for the compensation received.

Grade school arithmetic is sufficient to calculate that a student brilliant enough to pursue a scientific career can be thousands of dollars richer by the time he is 30 years old if he enters one of the crafts instead of science.

The main problem in America today is one of incentive.

Frank W. Brands
1202 Maiden Lane
Pullman, Washington

Wrong Time

To the Editor:

I believe the launch time given in the article "March 1 May Be Mars Probe Date," in a recent issue is in error.

In order to use the cotangential ellipse Mars must be 44.3 degrees ahead of the earth (relative to the sun) at launch time. This would place the probe vehicle in the vicinity of Mars some 250 days later.

The 1958 Martian opposition (November 16) has just passed, and our earth is presently pulling ahead of Mars. The next opposition does not occur until December 30, 1960. The angular velocity of Mars is about .524 degrees per day and that of the earth .987 degrees per day—their difference (or the amount the earth catches up to Mars) is .463 degrees per day. Mars will be 44.3 degrees (required launch angle) ahead of the earth (44.3/.463) 96 days prior to the 1960 opposition. This means that the Martian probe should be launched about September 25, 1960.

Robert Citron
Chairman
Space Flight Committee
Pacific Rocket Society

You're right, and we're wrong. Our space clock was running slow and your calculations are 100% correct. Thanks for correcting our error in the mechanics of the planets.

keeping track

by Peer Fossen

Sputnik III, according to reports from the Moscow Planetarium, at the end of November telemetered back to earth information about collisions with meteor bodies. At that time, the artificial Soviet moon, as well as our own globe, passed through meteor showers from the Leonids. Earlier, the satellite had passed through a powerful shower from the Orionids.

The large Soviet satellite carries a series of piezoelectric transducers for recording the number of micrometeor impacts. The Moscow report says these transducers are so sensitive that they can detect the impact of particles with a diameter of one micron and a mass of one billionth of a gram.

In the meantime, our own "boxcar-sized" *Atlas* satellite has proved that U.S. technology has made a great step forward, even though its payload weight is only a fraction of that of *Sputnik III.* The communication achievements experienced through this satellite are substantial, and the experiment, according to Dr. Elmer W. Engstrom of RCA: "opens up the early prospects of revolutionary communications techniques, such as international television, and microwave voice and code services on a global basis, using satellite relays capable of spanning the oceans."

RCA played a great role in the development of ARPA's Project SCORE instrumentation package, under contract with the U.S. Army. Of particular interest is the weight of the package. Among the light-weight equipment were:

Two transistorized receivers, each weighing ten ounces—enclosed in specially designed shock-resistant coverings—for receiving messages from the ground stations.

Two eight-watt transmitters, each weighing two-and-a-half pounds, to relay the messages on command to other ground stations. The transmitters were developed jointly by RCA and Radio Specialties Company.

Two electronic control units, each weighing three-quarters of a pound, to respond to commands from the ground. These units are used to activate the receivers, transmitters or magnetic tape system storing the radio messages.

Two beacon transmitters, each weighing three-quarters of a pound, for sending out a steady signal for tracking and temperature recording. This equipment was produced by Applied Science Corporation of Princeton under an RCA sub-contract.

In addition to the telemetering receiving station at the Cape Canaveral launch site, tracking of telemetering during the *Pioneer III* flight was accomplished at Mayaguez, Puerto Rico, and at Goldstone Tracking station, north of Barstow, Calif. The following tracking characteristics of these two stations were recently released by Dr. William H. Pickering of JPL:

	GOLDSTONE	PUERTO RICO
Transmitter carrier power	96 MW-19.8 dbm	96 MW-19.8 dbm
Vehicle antenna gain	2.5 db	2.5 db
Space loss at	−204.5 db at 250,000 miles	−190.5 db at 50,000 miles
Net ground antenna gain	39.4 db	21.5 db
Received signal	−142.8 dbm at 250,000 miles	−146.7 dbm at 50,000 miles
Receiver threshold	−153.5 dbm	−153.5 dbm
S/N for RF loop (20 cps BW) ..	10.7 db	6.8 db

MARMAN

Engineering Notes

W. M. WILLIS

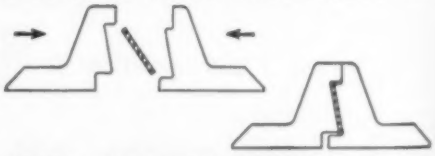
Scientific sealing, rather than the brute-force approach, is the feature of the Marman Conoseal that has successfully exceeded the sealing requirements of tomorrow's aircraft and missiles. As opposed to bolted flanges which invariably yield and loosen during thermal cycling, the Marman all-metal Conoseal closely approximates the flexibility of organically sealed joints and endures repeated extremes of thermal cycling while still maintaining a perfect seal.

In the low-temperature range (−320°F.) the joint has been successfully tested with liquid oxygen and liquid nitrogen using material transitions of aluminum flanges to stainless flanges. Recent experiments conducted by a leading airframe manufacturer have illustrated why the safety features of the Conoseal are a necessity. Impact sensitivity tests conducted by this company reveal that certain materials, such as synthetic elastomers, cellulose base papers, thermo-plastics and thermo-setting resins, including phenolics and silicones would explode when saturated with liquid oxygen and subjected to shock or impact. The chemical inertness of the all-metal Conoseal precludes any possibility of explosion during use of liquid oxygen, and in effect, is an anti-explosion joint.

Rigorous laboratory tests at Marman Division, Aeroquip Corporation, have proven the high-temperature and pressure-sealing capabilities of the Conoseal exceed the capabilities of pipe or tubing. Prototype tests now being conducted by various customers have demonstrated successful applications in liquid metals, such as liquid sodium at 1600°F. In outstanding tests of other applications, a 14-inch Conoseal used in a thrust vector control nozzle on a solid propellant rocket successfully withstood a nozzle temperature of 4600°F. for 90 seconds duration.

The Engineering Department at Marman has not overlooked the requirements of plant engineers and test equipment designers in the development of a 6400-series, heavy-duty pipe Conoseal. This rugged industrial joint retains all the maintenance, assembly, and sealing abilities of the aircraft joint, but is specifically designed for industrial usage.

Complete test reports are available upon request, covering performance of the four ranges of joint types available for your aircraft, missile, and industrial requirements.



Cross-sectional drawings of the CONOSEAL Joint show how the Belleville-type metal gasket is purposely compressed beyond its elastic limit to form a high pressure seal of counter balanced radial and axial forces.

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100% Metal! That's Why MARMAN CONOSEAL Joints Assure Unlimited Shelf Life With Perfect Seal

Marman's all-metal CONOSEAL Joint provides two basic advantages over organically sealed tube joints:

1—shelf life is practically unlimited
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The CONOSEAL Joint utilizes a new concept of metal-to-metal sealing in which the conical metal gasket is completely encased by mating flanges. Compressed radially and axially, the gasket forms a superior seal that withstands extreme pressures and wide thermal cycling. Distortion, shock, even minor linear deflections are absorbed without loss of seal.

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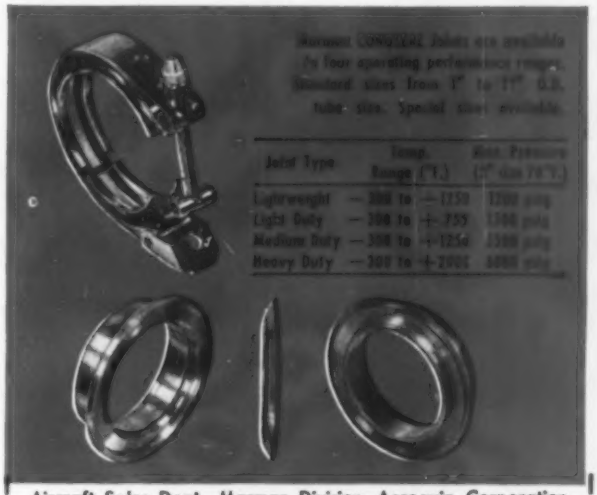

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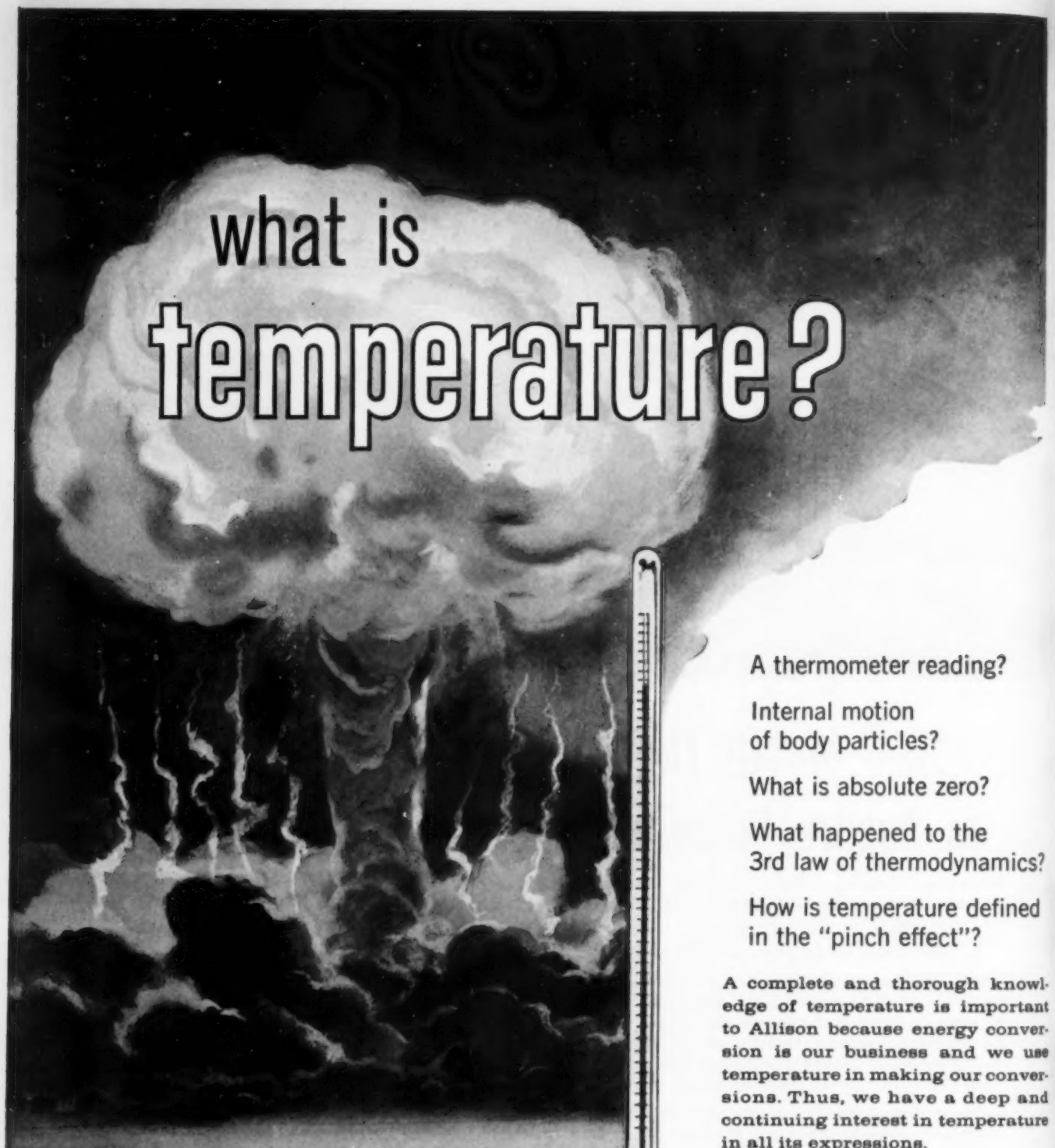

A thermometer reading?

Internal motion
of body particles?

What is absolute zero?

What happened to the
3rd law of thermodynamics?

How is temperature defined
in the "pinch effect"?

A complete and thorough knowledge of temperature is important to Allison because energy conversion is our business and we use temperature in making our conversions. Thus, we have a deep and continuing interest in temperature in all its expressions.

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Division of General Motors, Indianapolis, Indiana

contract awards

ARMY

By Boston Ordnance District, Army Base, Boston:

$99,450—**Fenwal, Inc.,** Ashland, Mass., for design, development and fabrication of temperature probes.

$199,918—**Avco Mfg. Corp.,** Everett, Mass., for reentry physics evaluation program.

By U.S. Army Engineer District, Corps of Engineers, Mobile, Ala.:

$1,042,253—**Redstone Arsenal,** Ala., for construction of propellant development facilities.

NAVY

By U.S. Navy Purchasing Office, Los Angeles:

$41,330—**Philco Corp.,** Philadelphia, for services of electronic and communication equipment in missile flight test programs.

By District Public Works Office, U.S. Naval Base, Charleston, S.C.:

$30,000—**Soil Consultants, Inc.,** Charleston, S.C., for engineering services for *Polaris* missile assembly facilities, Naval Ammunition Depot, Charleston, S.C.

$434,220—**Wells Benz, Inc.,** San Diego, Calif., for construction of facilities Point Arguello, Calif.

AIR FORCE

By the U.S. Signal Corps, Ft. Monmouth, N.J. and Space Technology Laboratories, Inc., Los Angeles:

$791,000—**The Semiconductor Division of Hoffman Electronics Corporation** for solar energy converters.

By the Air Materiel Command at Wright-Patterson Air Force Base:

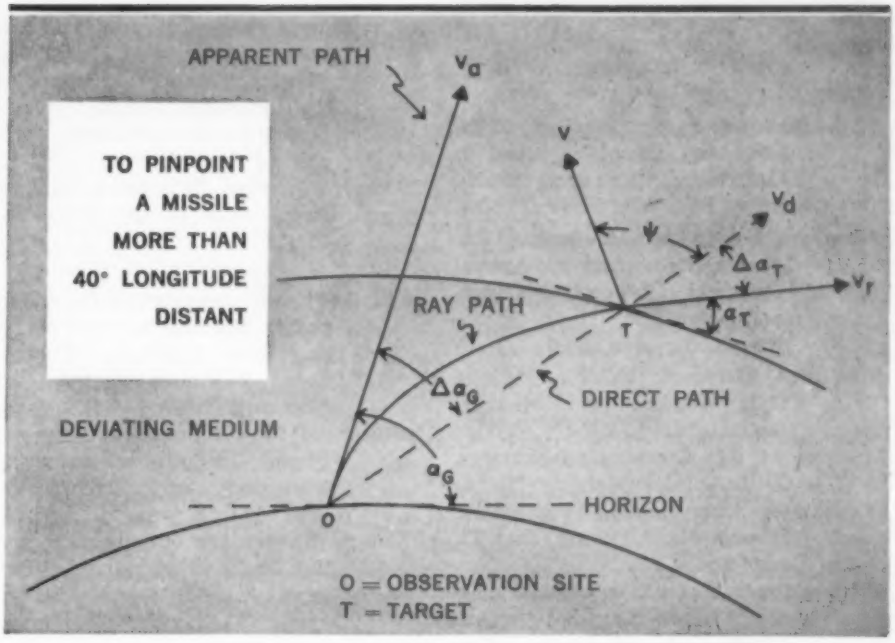
$1,491,310—**Goodyear Corp.,** Akron, Ohio, for changes in the *Mace* missile.

By the Guided Missile Division of Firestone Tire & Rubber Co.:

$700,000—**Clary Dynamics,** San Gabriel, Calif., for gyroscopes, servo-actuators and valves for use on the *Corporal.*

By Headquarters, Air Force Cambridge Research Center, Bedford, Mass.:

$99,000—**The University of Chicago,** for research concerning the solar-geophysical aspects of cosmic radiation and magneto-hydrodynamics.



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JANUARY

Fifth National Symposium on Reliability and Quality Control in Electronics, Bellevue-Stratford Hotel, Philadelphia, Jan. 12-14.

American Society of Mechanical Engineers, 1959 Second Annual Technical Conference, Huntington-Sheraton Hotel, Pasadena, Calif., Jan. 21.

Southwest Electronic Exhibit, Arizona State Fairgrounds, Phoenix, Jan. 21-23.

Institute of the Aeronautical Sciences, 27th Annual Meeting, Sheraton-Astor Hotel, New York. Honors Night Dinner, Jan. 27, Jan. 26-29.

Fifth Annual Radar Symposium (classified), Rackham Bldg., University of Michigan, Ann Arbor, Jan. 27-29.

Society of Plastics Engineers, 15th Annual Technical Conference, Hotel Commodore, New York, Jan. 27-30.

Armour Research Foundation, Fifth Annual Midwest Welding Conference, Illinois Institute of Technology, Chicago, Jan. 28-29.

FEBRUARY

14th Annual Technical and Management Conference, Reinforced Plastics Division, Society of the Plastics Industry, Inc., Edgewater Beach Hotel, Chicago, Feb. 3-5.

1959 Engineering Exposition, Balboa Park, San Diego, Feb. 26-March 1.

MARCH

IRE, AIEE and Association for Computing Machinery, 1959 Western Joint Computer Conference, Fairmont Hotel, San Francisco, March 3-5.

Institute of the Aeronautical Sciences, Flight Propulsion Meeting (classified), Hotel Carter, Cleveland, March 5-6.

Western Space Age Conference and Exhibit. For information: Domestic Trade Dept., Los Angeles Chamber of Commerce, 404 South Bixel St., Los Angeles, March 5-7.

Gas Turbine Division of the American Society of Mechanical Engineers, Turbine in Action, Cincinnati, March 8-11.

American Society for Metals, 11th Western Metal Exposition and Congress, Pan-Pacific Auditorium and Ambassador Hotel, Los Angeles, March 16-20.

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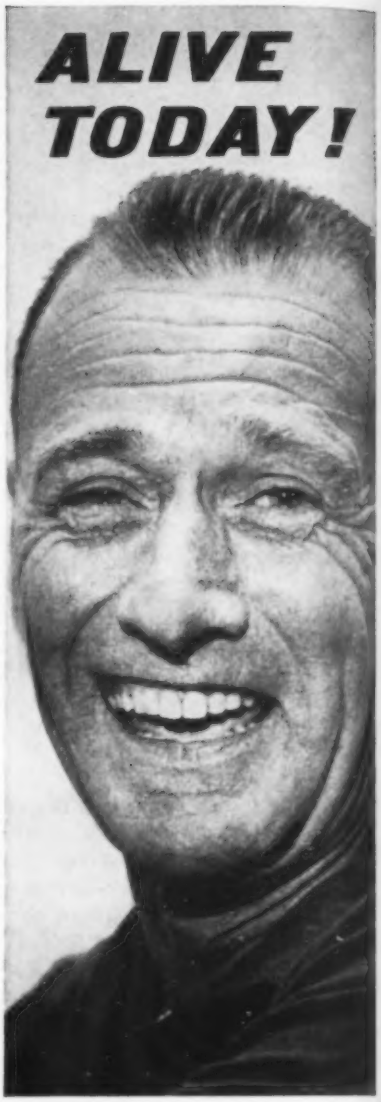

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You can do two things to defeat cancer: Have an annual health checkup. Be alert to the 7 danger signals that could mean cancer:

1. Unusual bleeding or discharge. 2. A lump or thickening in the breast or elsewhere. 3 A sore that does not heal. 4. Change in bowel or bladder habits. 5. Hoarseness or cough. 6. Indigestion or difficulty in swallowing. 7. Change in a wart or mole. If your signal lasts longer than two weeks, go to your doctor to learn if it means cancer.

AMERICAN CANCER SOCIETY

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advertisers' index

Aeronca Mfg. Corp. 8
Agency—Penn & Hamaker, Inc.
AiResearch Mfg. Co., Div. of The Garrett Corp. 25
Agency—J. Walter Thompson Co.
Alcoa Aluminum Co. of America 32
Agency—Fuller & Smith & Ross, Inc.
Alden Products Co. 42
Agency—Copley Adv. Agency, Inc.
Allegheny Ludlum Steel Corp. 26
Agency—W. S. Walker Adv., Inc.
Allison Div., General Motors Corp. ... 50
Agency—Kudner Agency, Inc.
Bendix Aviation Corp.
Bendix Products Div. 55
Hamilton Div. 28, 29
Red Bank Div. 35
Scintilla Div. 53
Agency—MacManus, John & Adams, Inc.
Bristol Co., The 42
Agency—James Thomas Chirurg Co.
Christie Electric Corp. 34
Agency—Len Woolf Co.
Divco-Wayne Co. 11
Agency—Perry-Brown, Inc.
Dyna-Therm Chemical Corp. 4
Agency—Taggart & Young, Inc.
Electrical Engineering & Mfg. Corp. 6
Agency—MacManus, John & Adams, Inc.
A. B. Farquhar Div., The Oliver Corp. . 43
Agency—Foltz-Wessinger, Inc.
Graphic Systems, Inc. 38
Agency—Diener & Dorskind, Inc., Adv.
A. W. Haydon Co., The 52
Agency—Cory Snow, Inc.
Hewitt-Robins Industrial Products 24
Agency—Fuller & Smith & Ross, Inc.
Hughes Aircraft Co. 44
Agency—Foote, Cone & Belding
International Business Machines Corp. 46, 47
Agency—Benton & Bowles, Inc.
Lebanon Steel Foundry 33
Agency—Howard E. Marshall Adv.
Ling Electronics, Inc. 56
Agency—John Ramsey Co., Adv.
Lockheed Aircraft Corp., Missile System Div. 10
Agency—Hal Stebbins, Inc.
Lord Mfg. Co. 20
Agency—The Jayme Organization, Inc.
Marman Div., Aeroquip Corp. 48, 49
Agency—The Fred M. Randall Co.
Missiles & Space Systems Div., United Aircraft Corp. 31
Agency—G. F. Sweet & Co.
North American Aviation, Inc., Autonetics Div. 19
Agency—Batten Barton Durstine & Osborn, Inc.
Pan American World Airways, Inc. 36
Power Sources, Inc. 41
Agency—Chambers, Wiswell, Shattuck, Clifford & McMillan, Inc.
Propellex Chemical Corp. 36
Agency—Al Maescher Adv., Inc.
Raytheon Mfg. Co. 30
Agency—Donahue & Coe, Inc.
Servomechanisms, Inc. 2
Agency—Hixson & Jorgensen, Inc.
P. A. Sturtevant Co. 38
Agency—Ross Llewellyn, Inc., Adv.
Thompson-Ramo-Wooldridge Inc. 45
Agency—Meldrum & Fewsmith, Inc.
Thompson Ramo-Wooldridge, Inc. 3
Agency—The McCarty Co.
Vickers, Inc., Div., Sperry Rand Corp... 12
Agency—G. F. Sweet & Co.
Vickers, Inc., Div., Sperry Rand Corp. .. 39
Agency—Witte & Burden

Employment

General Electric Co. 51
Agency—Deutsch & Shea, Inc.
Marquardt Aircraft Co. 43, 52
Agency—Grant Adv., Inc.
Republic Aviation Corp. 37
Agency—Deutsch & Shea, Inc.

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The Case of Dr. York and Mr. Johnson

Separated by only a few feet on the third floor of the Pentagon are the offices of the Advanced Research Projects Agency and the Defense Department's new Directorate of Research and Engineering.

Heading the latter office is Dr. Herbert F. York, physicist. Heading ARPA is Roy Johnson, businessman. Before Dr. York's Christmas Eve appointment he was chief scientist of ARPA. In his present post he takes precedence just behind the service secretaries and is paid the same salary they get — $22,500 annually. Johnson, somewhat lower in the DOD protocol scale, is paid $19,000. Dr. York's post was established by law, Johnson's by Defense Department fiat. Both men took severe pay reductions in accepting their posts, Johnson probably the greatest. Both are forthright, out-going and competent.

This much is clear and understandable fact. But at his first press conference Dr. York couldn't do much to clear up a score of questions about the dual capacities of two agencies. To reporters who asked about such matters as authority, budget and areas of operation, it sounded like the old story of who does what to whom and who pays.

Dr. York verified previous word that ARPA was a permanent part of DOD and he said he saw no conflict between ARPA and his office. Yet:

Both Johnson and York report directly to Defense Secretary McElroy.

Both supervise, direct or perform research and engineering projects in DOD.

Both are authorized to arrange for R&D work by other government agencies.

Both are authorized to enter into private contracts for R&D work with private business or scientific agencies.

Both perform at the pleasure of the Secretary of Defense, although Congress may claim a proprietary interest in Dr. York.

ARPA has taken over the entire field of military space, although it does not limit itself to this field. ARPA's officials, and apparently Secretary McElroy, look upon ARPA and refer to it as a fourth service set up for the single management of all military space projects. ARPA has to date worked through the services although it is authorized to "acquire or construct such research, development and test facilities and equipment as may be approved by the Secretary of Defense."

The charter of the new R&E office certainly encompasses the space field as well, and how the new Directorate will divide its field with ARPA, or vice versa—or what could happen at the first test of strength between the two—is difficult to conjecture.

But this is not the most critical aspect of this situation in a highly critical field. The grave danger lies in what is accomplished or not accomplished in the field of military space projects.

ARPA has its own budget (well under half a billion projected) and must pay for every operation it assumes. The services have no money for space projects in their 1960 budgets. Any military space experiments or achievements they may wish to undertake are limited by the decisions and the budget of ARPA, the fourth service.

Roy Johnson has said that in the case of a technological breakthrough ARPA could always get more money from Secretary McElroy's emergency fund to cover his own budget deficiencies. Presumably he could or perhaps the Defense Department's new R&E budget, which Dr. York must defend before Congress, will contain items for space projects. He may not be limited. Perhaps his office could become the *fifth* service.

The very grave danger is that in the confusion resulting from this divided authority, from this juggling of the bright balls of military space projects one of them may be dropped or even left completely out of the act. Certainly Dr. York and Roy Johnson are sincere and honest gentlemen and certainly they took their present jobs with the most honest of intentions. But it would take a saint to keep his temper and a Solomon to adjudicate the roles each must play under the present setup.

Certainly we must have civilian control over the military including the military operating in the solar areas but let's have a reasonably clear-cut control and not an Alphonse and Gaston act. M/R believes and has said repeatedly that the military equipment necessary to prevent any other force from controlling space is the greatest requirement of the free world today. We believe that our military leaders are best qualified to define that equipment; that they should have a clear line of authority before which to present the projects they need and no arbitrary limit on the money necessary to research, develop and procure them.

Lunik certainly does nothing to de-emphasize this.

Clarke Newlon